Geological Survey of North Carolina.

ORES

OF

NORTH CAROLINA.

BY W. C. KERR AND GEO. B. HANNA.

PROF. J. A. HOLMES,

Acting as State Geologist.

DEAR SIR:—At your request and with your assistance, I have undertaken to prepare for publication the material relating to the ores of North Carolina accumulated by the late State Geologist, Professor W. C. Kerr.

I cannot hope to have emulated the skill which he showed in the collation of his data, but my close relations with him for a long term of years, and my great respect for his memory, have prompted me to do whatever I could.

In my long connection with the U. S. Assay Office, Charlotte, N. C., I have come into possession of a large fund of facts respecting the mining resources of the State. These facts were freely given to him, and he reciprocated, so that there came in time to be, as it were, a common fund of information, and, to a great degree, a community of views.

About one third of this mass of material had been put into shape by him, and in compiling the rest, I have endeavored to represent him, whenever possible; I have avoided theorizing, that I might not misrepresent him. The whole is compiled rather from the standpoint of the mining engineer than from that of the geologist.

About two thirds of the section on iron, and a large part of that on copper are his; in those on lead and gold a considerably larger part is due to the result of my own compilation.

It is fitting to acknowledge the assistance received from many sources, particularly to superintendents of mines. Among others who contributed much and freely are Messrs. T. K. Bruner, Salisbury; John Wilkes, Charlotte; Calvin J. Cowles, Wilkesboro; the late Dr. Daniel Asbury, and Mr. Edward H. Bissell. The entire material of the latter gentleman, covering a period of more than fifty years' observation and experience, was placed at my disposal.

GEORGE B. HANNA.

U. S. Assay Office, Charlotte, N. C.,
February 26th, 1887.

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CHAPTER II.

ORES.

Section 1. IRON.

The ores of iron are very widely distributed in this State, their occurrence being not only co-extensive with the area of the Archean (or Azoic) rocks, but extending over a part of the Mesozoic, and into the region of the Tertiary. These occurrences include all the principal kinds of ore: Magnetite, Hematite, Limonite, and Siderite, and most of their varieties. As many of these forms are found in association or in close proximity, it will avoid confusion to consider them by districts—to group them geographically.

We begin with the most easterly occurrences:

But for the benefit of the reader who is not familiar with mineralogy, it may be proper to state that Magnetite, (*magnetic iron ore, gray ore, black ore,*) a granular, hard, dark to black, heavy mineral, contains, when pure, 72.4 per cent. of metallic iron; Hematite, (*specular iron, red hematite, red iron ore,*) 70 per cent.; Limonite, (*brown hematite, brown iron ore, brown ochre, bog iron ore, etc.*) very nearly 60 per cent.; Siderite, (*spathic ore, carbonate of iron,*) 48.28 per cent. These ores are never found in a state of purity in workable beds, but contain various impurities, earthy or mineral, in varying proportions, e. g., silica, alumina, lime, magnesia, manganese, sulphurets, and phosphates, etc., so that practically an ore which yields 40 to 50 per cent. of iron in the furnace is a good ore.

Limonite Ores of the East.

The clayey, sandy and earthy accumulations of the eastern section contain in many places a rough brown ore, more or less earthy or sandy, either in beds 2 to 4 feet in thickness, or more frequently in layers of irregularly shaped lumps or nodules.

Blomary Mine.—One of the most considerable of these deposits is found in the southern end of Nash county, near the Wilson line; it is in the form of a horizontal, continuous bed, of a loose, spongy texture,

and rusty brown color, except in a few points, where it becomes more compact and of a submetallic lustre. It lies on the edge of Toisnot Swamp. The thickness is 2 to 3 feet, and its horizontal extent about 50 yards by 150. It is known as the Blomary Iron Mine, from the fact that iron had been made from this ore in a Catalan forge a few miles south during the war of 1812. Iron was also made here during the Confederate war in a furnace erected on the spot. Its reputation was good, and there is a tradition in the neighborhood, that the forge iron was a sort of natural steel. The following is the analysis of a fair sample of the bed lately selected:

ORE FROM THE BLOMARY MINE.	(1)	
Silica	15.06	per cent.
Alumina	0.55	"
Sesquioxide of iron	60.74	"
Protoxide of iron	0.24	"
Sulphide of iron	0.06	"
Oxide of Manganese	1.56	"
Lime	1.43	"
Magnesia	1.54	"
Sulphuric acid (anhydride)	0.03	"
Phosphoric acid (anhydride)	0.11	"
Organic matter and water	15.58	"
Metallic iron 42.73 per cent.		

This analysis places the ore among the best of its class.

A second deposit, reported to be abundant in superficial nodules and irregular lumps, is found in the southern part of Duplin county near Wallace, on the farm of D. T. Boney. The following is a partial analysis of an average specimen from a box of about 50 pounds sent to the Museum:

ORE FROM FARM OF D. T. BONEY.	(2)	
Silica	7.59	per cent.
Oxide of iron	77.03	"
Sulphur	0.05	"
Phosphorus	0.02	"
Metallic iron 53.93 per cent.		

This ore is often in quite large and tolerably compact lumps, of a reddish brown color, and slightly magnetic.

Another bed of the same character and appearance, except in the

size of the nodules, which are rather small, occurs in a field about two miles north of Rocky Point in New Hanover.

Extensive beds of limonite are reported (by Col. R. W. Wharton) to occur on the border of Tranter's Creek, near the Tar River, in the eastern portion of Pitt county. The ore occurs in the "second bottom" about 10 feet above water level in the creek, at or near the surface, sometimes in large lumps and blocks; in other places it is found in solid beds.

It is reported also as occurring on Tar River near the town of Washington, several miles above the mouth of Tranter's Creek.

Specimens of the same sort have been frequently sent to the Museum from other points east—Edgecombe, Pitt, Halifax and Robeson, for example—showing that this kind of ore is of common occurrence in that region.

Hematites of Halifax and Granville.

Gaston Ore Beds.—On the hills fronting the Roanoke, less than a mile below Gaston, are several outcrops of hematite ore.

There are two principal beds, of which the lower only has been opened. The ore is granular, for the most part, and of the variety known as specular, but contains a considerable per centage of magnetic grains disseminated through it. On the south side of the river, the bed has been exposed for several rods on the upper slope of the hill, at an elevation of about 100 to 150 feet above the surface of the water. The ore is generally slaty, impregnating and replacing the argillaceous, quartzitic and chloritic strata, which constitute the Huronian formation at this locality. This lower bed is double, another parallel outcrop appearing at the distance of about 100 yards. The strike is N. 20° E., and dip eastwards 80° The principal bed is about 20 inches thick at the surface. There is a re-appearance of it on the other hill front about a mile distant, on the north side of the river, the ore being of the same character, but a little less slaty. It gave on analysis 63.76 per cent. of iron, and 0.09 per cent. of phosphorus.

The accompanying plate (plate I) shows the relations of the different outcrops to each other and to the topography, and also a larger outcrop of another bed nearly half a mile northwest. The course of this last bed is marked by numerous surface fragments scattered quite widely. The ore, in this case, is more compact and less slaty; the inclosing rock is a gray gneissoid quartzite.

The analyses of both these beds are added below:

ORE FROM GASTON ORE BEDS.	(3)	(4)
Silica	9.10	10.12
Alumina	6.18	....
Oxide of iron	83.96	....
Lime	0.22	....
Phosphorus	0.00	0.05
Sulphur	0.03	0.08
Metallic iron	58.73	53.31

The upper bed last described, is represented by No. 3, the lower by No. 4. These analyses were made by Mr. G. Lobdell for the owners, by whose courtesy a copy of them was obtained for this report.

About 5 miles southward from the above locality the same bed makes its appearance on the farm of Mr. Hines. Here, however, it is highly magnetic, fine grained and dense, although still showing the decidedly slaty structure of the first of the Gaston beds. At this point it is represented as 3 to 4 feet thick.

These ores are of conspicuous purity and obviously adapted to the manufacture of the higher grades of iron and of steel. There is evidently here a range of ore-beds of considerable extent.

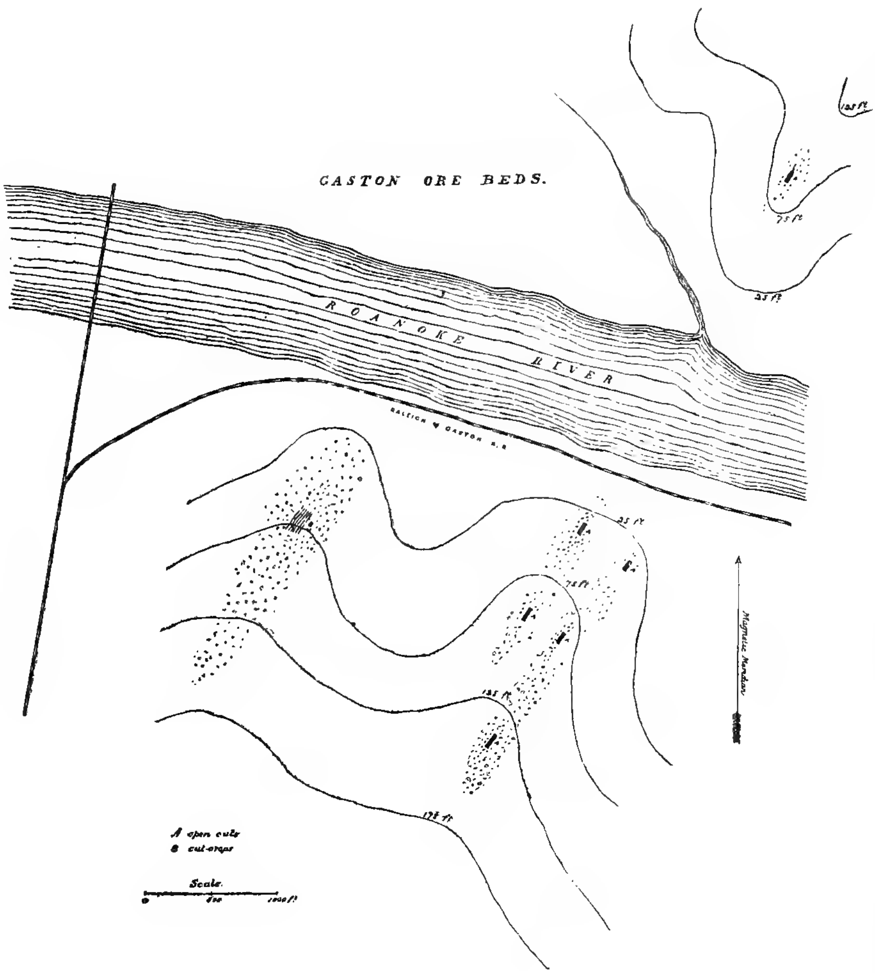
Magnetic iron ore occurs 10 miles east of Littleton and 6 miles south of Gaston. Red Hematite is found one-third mile below Gaston.

In Granville county, about a mile north of Tar River, and the same distance eastward from Fishing Creek, is an outcrop of a coarse, granular, somewhat slaty magnetic ore, having very much the appearance of that of the upper bed at Gaston. The rock is a felspathic talco-quartzitic and chloro-quartzitic schist. The bed is revealed only by the numerous fragments scattered over the surface through the forest for several rods along the roadside. This ore is in a small triangular patch of Huronian schists, intercalated between the older rocks of the region. It is reported that there are other outcrops of iron ore near Rainey's mill, and also in the neighborhood of Lyon's mill, but I have not seen either of them.

Iron Ores of Johnston and Wake.

There is, according to Dr. Emmons,* "a large deposit" of Limonite

* Geological Report of Midland Counties of North Carolina, 1856, pp. 125–127.



GASTON IRON ORE BEDS,

Showing the relations of the different outcrops of ore to each other and to the topography of the region.

4 miles west of Smithfield, Johnston county. The specimens brought to the Museum by Mr. Guest, the owner of the land (1875), resemble very closely the bog ore of Duplin county. They are more or less sandy and earthy, irregular lumps or nodules.

Another "bluff" of limonite is referred to by Emmons* as found at Whitaker's, 7 miles southwest of Raleigh, Wake county. These last two are in the Huronian schists. Hand specimens of very coarsely crystalline magnetite of 10 to 15 pounds weight, associated with syenite, are found within a mile of Raleigh; compact hematite also occurs in veins in the same vicinity.

These and other specimens of these species and of limonite are from different parts of these counties,** and are from the surface, as no openings have been made. They indicate the very common occurrence of these ores.

Iron Ores of Chatham and Orange.

Buckhorn Mine.—One of the best known mines of this region is the Buckhorn mine, about 7 miles below the fork of the Cape Fear River, on a hill nearly 200 feet high, overlooking the river from the left bank, near the border of Harnett county. Its location will be easily understood from the accompanying topographical sketch (plate II). The ore occurs as a bed, capping the hill and sloping from the river, with a dip of 2° to 25° towards the northwest.

The lower part of the bed, which contains much manganese, and less iron in proportion, is of a mottled gray and dull reddish color at the summit, and at the distance of 200 or 300 yards along the slope, is a light colored, gray and spotted (black and dirty white) ferriferous manganesian slate.

Occasional sheets of laminated black oxide of manganese, 1 or 2 inches thick occur in the bed. Some parts of the bed are slightly magnetic. The outcrop, or rather the terminal face of the bed at the opening, on the summit of the hill, is shown in the annexed diagram:

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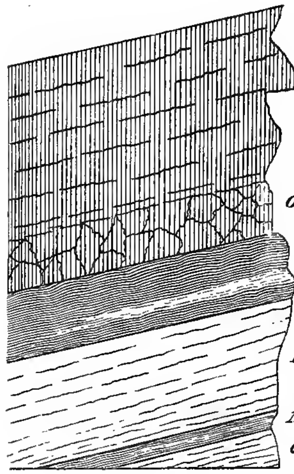
* Geological Report of Midland Counties of North Carolina, 1856, pp. 125–127.

** Limonite from near Leachburg, Johnston county; Magnetite from near Smithfield, Johnston county, may be mentioned especially.



BUCKHORN SECTION.

The ore is properly described as specular; it is of a dull, dark gray to blackish color, subcrystalline structure, and uneven fracture; the streak is dark red. Occasionally pieces of the ore show a tendency to lamination, and in such cases the divisional planes are commonly coated with mica crystals.

The mine was extensively operated a few years since, and the supply of valuable ore was exhausted There are other valuable ore deposits in the vicinity, but examinations sufficient to determine the extent and value of the deposits have not yet been made.

The rocks of this region are slaty gray gneiss, and mica slate, with occasional patches of massive, light gray granite. The rock which underlies the ore (see the above "section") is a light-colored, felspathic slaty gneiss, which readily decomposes.

Douglass mine.—The neighboring hills, at the distance of half a mile, both north and south, are reported to show many scattered fragments of the same ore on the surface; and on the right bank of the river, on nearly the same level with the Buckhorn mine, at the distance of about 1 mile southwest is the Douglass mine (see plate II). This is a recurrence of the Buckhorn bed, on the scale and with the features of its lower exposure, being more schistose in structure, some of the strata being in fact simply gneiss and mica slate, with disseminated grains and laminæ of hematite (and magnetite), and the lower strata passing into a slaty manganesian silicate. The thickness, which is not fully exposed, seems to be 10 to 12 feet. Angular fragments of dark, dense, granu-

Missing Page

lar ore, with a black manganese stain, are scattered over several acres of the hill top, indicating a wide extension of the bed.

From the facts stated, it will be apparent that these different beds are mere remnants of an ancient and very extensive deposit, which has been almost entirely removed by denudation, and carried away by the erosive action of the river.

Pegram Mine.—About 1 mile north of the Buckhorn mine (see plate II) is a small vein about 1 foot thick, of a highly magnetic ore. Its strike is N. 60°, and dip eastward 30°; the gangue is an epidotic quartzite. There are two openings on the vein, called the Pegram Mine. An analysis of this ore for the owners by C. E. Buck gave 56.57 per cent. of iron and 1.51 per cent. of titanic acid.

This group of mines has been worked by the American Iron and Steel Company. The product was mostly a spiegeleisen, of which the following analyses, by Mr. Lobdell, will show the character:

SPIEGELEISEN, BUCKHORN FURNACE	(5)	(6)	(7)
Manganese	4.573	6.50	4.88
Silicon	0.233	0.14	0.38
Sulphur	0.015	0.009	....
Phosphorus	0.051	0.12	0.095

The origin of this peculiar and valuable product will be evident on the inspection of the analyses given below. They were made by G. G. Lobdell and C. E. Buck, of Wilmington, Del., and by the chemist of the Pennsylvania Steel Company:

ORES FROM BUCKHORN (8 TO 11) AND DOUGLAS MINE (12).

	(8)	(9)	(10)	(11)	(12)
Silica	14.45	5.65	12.80	30.50	7.50
Alumina	....	0.80	5.20	19.20	8.49
Oxide of Manganese	....	trace	....	22.80	7.52
Phosphorus	trace	....	trace	0.02	0.04
Sulphur	0.06	....	trace	0.03	0.02
Iron	56.70	66.50	54.15	18.41	55.00

Of these, Nos. 8, 9 and 10 are from the upper and main part of the Buckhorn bed, and No. 11 from the manganesian section. This last analysis suggests the presence, in this part of the bed, of the mineral knebelite, a characteristic ore of the most famous Swedish Spiegeleisen mines. No. 12 is the Douglass ore on the other side of the river.

Besides the localities already mentioned, a number of additional outcrops of ore, mostly magnetic, have been noted; one, for example, 2

miles north of Buckhorn, at Dewer's, yielding 57.77 per cent. of iron, and without sulphur or phosphorus, and three or four others in a southwest direction, for 10 miles, to the head waters of Little River—at McNeil's, Dallrymple's and Buchanan's. Analyses by Lobdell, are as follows, respectively:

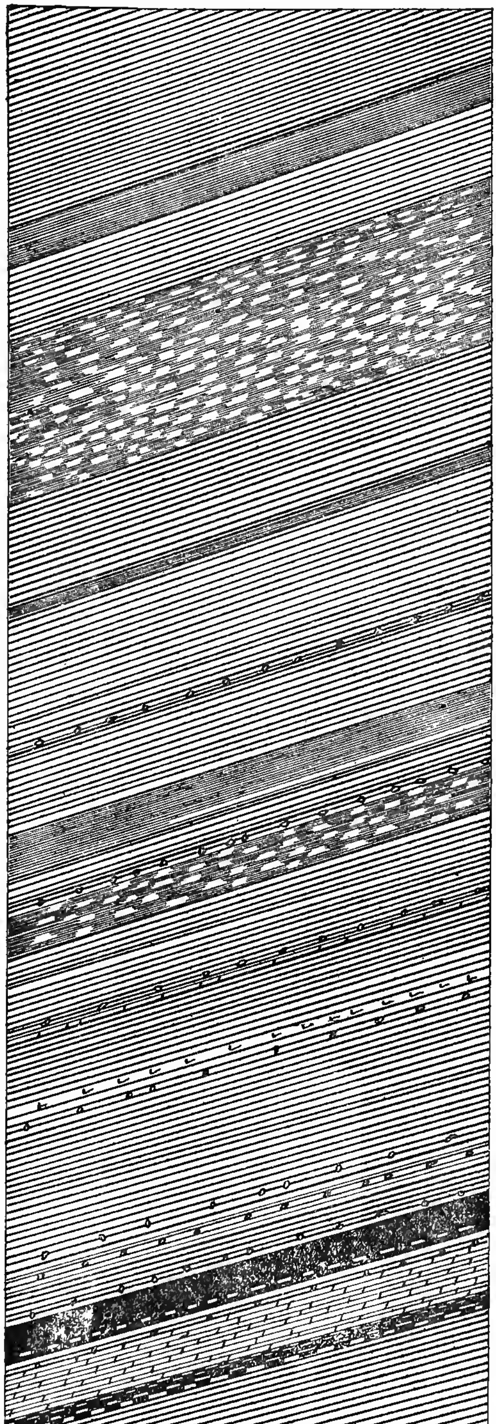
ORES FROM MCNEILL'S (13), DALLRYMPLE'S (14) AND BUCHANAN'S (15), CHATHAM COUNTY.

	(13)	(14)	(15)
Iron	52.90	36.47	53.25
Sulphur	0.05	0.05	0.04
Phosphorus	0.12	0.11	0.57

Near Haywood, in the angle formed by the junction of the Haw and Deep rivers, in the red sandstone of the Triassic, there has been opened a series of parallel beds of a red ochreous earthy ore, on the lands of Dr. Smith, (1875). The only bed exposed at the time of my visit, was 20 to 25 inches thick, dipping southeast with the sandstone, 20° to 30°. The ore has a rough likeness to the "Clinton" or "Fossil ore" of New York, and the "Dystone" of Tennessee, but has a much coarser and more irregular texture, and is composed of rounded concretionary masses of various sizes from that of the Clinton grains to ¾ inch and upwards. It is commonly more or less compacted into conglomeritic masses, often of the entire thickness of the bed, but frequently it is loosely and slightly compacted, and when thrown out, crumbles to a heap of very coarse gravel. The ore is partly limonite, but seems to be largely changed to red hematite. The following analyses of samples taken from different parts of the beds, whose outcrops extend over an area of several acres, will exhibit the character of the ore. The second of the analyses (No. 17) represents the ore as it occurs on the lands of Richard Smith, adjoining the preceding.

ORES FROM LANDS OF DR. SMITH (16) AND RICHARD SMITH (17), NEAR HAYWOOD.

	(16)	(17)
Silica	----	23.50
Alumina	----	2.54
Sesqui-oxide of iron	69.73	67.50
Protoxide of iron	0.84	----
Bisulphide of iron	0.17	----
Phosphoric acid (anhydride)	0.10	----
Lime	----	0.90
Magnesia	----	0.24
Water and loss	----	5.03
Iron	49.56	47.25



Black slates.

Calcareous slates.

Green calcareous shales.

Bituminous shales.

Calcareous shales.

Bituminous slates.
Ball ore.

Calcareous shales.

Black slates and ball ore.

Green calcareous shales.

Black slates.

Black slates and ball ore.

Fire clay and ball ore.

Sandstone.

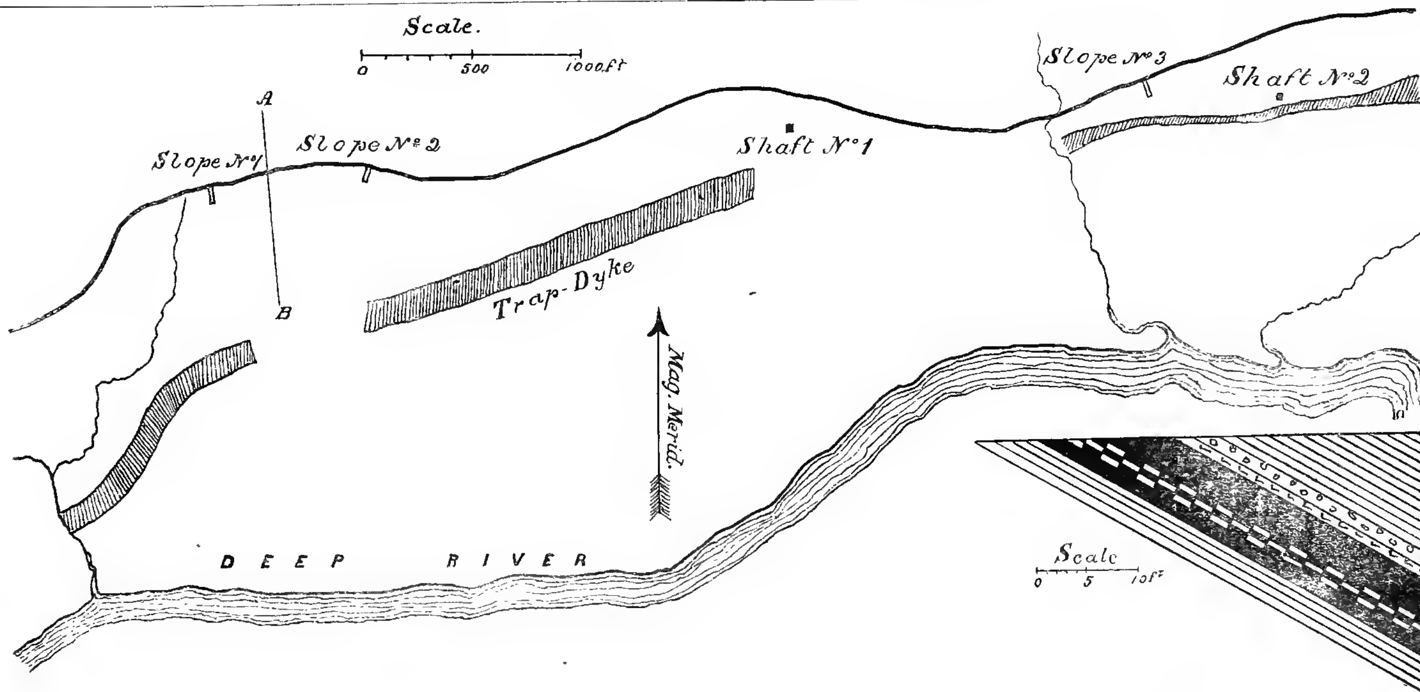
Coal.
Black band ore.

Bituminous shales.
Gray sandstone.
Coal and black band.

Black slates.

SECTION OF EGYPT COAL SHAFT, CHATHAM COUNTY, 460 FEET DEEP.

Showing the occurrence of ball and black band ore and coal.



OUTCROP AND SECTION OF COAL AND BLACKBAND ORE AT THE GULF, CHATHAM COUNTY.

The map of the outcrop is copied from a local survey made in connection with some mining operations carried on here during the civil war. The section on the line A-B is added from a shaft sunk subsequently to a depth of 20 feet through the two upper seams of coal and the intervening stratum of black band dipping south 32°. The section is as follows: Black slates and shales, 8 feet (from the surface); fire clay and ball ore, 4 feet; coal, 4 feet; blackband ore, nearly 2 feet; coal, 1½ feet; black slates at bottom.

This ore makes its appearance again about a mile from Sanford, some twelve miles distant, where it was opened and worked to some extent during the late war. Only one bed was exposed here, which is about 20 inches thick.

The ore is easily dug and shoveled from the bed, and crumbles into a heap of very coarse, reddish-brown gravel—a rough sort of shot ore. The preceding analysis will nearly enough represent the composition of this also.

Blackband and Ball Ores.—The next ores demanding attention are the Blackband and Ball ore, or "kidney ore" of the coal measures. These are earthy and calcareous carbonates of iron, imbedded in the black carbonaceous shales, which enclose the coal, or interstratified with the coal itself. These ores seem to be co-extensive with the coal on Deep River, outcropping everywhere with it, and at several places outside of its limits.

Two seams are shown in the accompanying sections, (plates III and IV) and there is a third in the bottom shales, not penetrated at the Gulf, but shown in the Egypt section, as accompanying the lower coal, 30 feet below the main seam.

Emmons* also speaks of another argillaceous carbonate as occurring at the depth of 230 feet in the shaft at Egypt, and four occurrences of it are indicated as ball ore in the Egypt section.

He says of this carbonate:* "It contains 33 per cent. of metallic iron; the surface ores, being altered, contain 50 per cent."; he also says that it occurs in "balls, or in continuous beds."

About the Gulf it is found in rounded, flattish masses, 5 or 6 to 8 or 10 inches in diameter. They are dense, uncrystalline and heavy, of a light gray to drab color, and are pretty thickly distributed in parallel layers of 1 to 3 feet in thickness. An analysis by Prof. Schaeffer, as given in Admiral Wilkes' Report to the Secretary of the Navy in 1858, is as follows:

BLACKBAND ORE FROM NEAR THE GULF.	(18)	
Protoxide of iron	40.00	per cent.
Silica	13.00	"
Earthy matter	13.00	"
Carbonaceous matter	34.00	"

*Geology of the Midland Counties, 1856, p. 262, *et seq.*

The following is the analysis by Buck, of the ball ore proper, as it occurs at the Gulf, and such as was used extensively and successfully as a flux during the late war:

BALL ORE FROM THE GULF.	(19)
Silica	6.04
Alumina	0.48
Protoxide of iron	14.51
Sesquioxide of iron	1.63
Lime	29.57
Magnesia	6.51
Carbonic Acid	38.30
Phosphoric Acid (anhydride)	0.92
Sulphuric Acid (anhydride)	0.19
Organic matter	1.45
Water	0.40

There are many outcrops of ferriferous limestone in the vicinity of Egypt. The following analysis is of a specimen taken from near Dowd's saw mill:

FERRIFEROUS LIMESTONE, NEAR EGYPT.	(20)
Lime	31.68
Magnesia	0.79
Sesquioxide of iron	9.60
Sulphur and Phosphorus	none.

Oyster shells from the Tertiary bluffs below Fayetteville, and limestone from the Eocene beds about Wilmington, have also been used as fluxes, and on account of their purity and cheapness, will doubtless become the chief resource for this purpose.

The seam of *blackband* between the main coal beds in the Egypt shaft, is stated by Wilkes to be 16 inches, and the lower one to consist of two thicknesses of 3 feet each, separated by a thin seam of coal between. He adds, " this ore is readily distinguished from a slate by its brownish black color." The following analysis of this ore is by Dr Jackson*:

BLACKBAND ORE FROM THE EGYPT SHAFT.	(21)
Carbon	31.30
Peroxide of iron (Protoxide ?)	47.50
Silica	9.
Volatile matter	8.81
Sulphur	3.39

*Emmons' Geoloy of Midland Counties, 1856, p. 264.

Emmons adds: " the roasted ore gives sulphur 0.89 per cent."
An analysis of this ore by Schæffer for Wilkes gives:

BLACKBAND ORE FROM EGYPT SHAFT.	(22)
Metallic iron	17.00 per cent.
Carbonaceous matter	42.00
Specific gravity	2.12

The following analyses of samples selected from a recent opening at the Gulf, represented in the section given above, were made for the survey by Mr. G. B. Hanna:

BLACKBAND ORES FROM THE GULF.

	(23)	(24)	(25)	(26)
Specific Gravity	2.361	3.150	2.110	2.110
Silica	9.154	7.089	34.390	5.188
Alumina	4.244	0.127	19.658	4.060
Protoxide of iron	19.419	33.802	12.371	9.614
Sesquioxide of iron	0.000	1.755	1.430	0.938
Sulphide of iron	10.485	2.145	2.023	7.146
Oxide of manganese	1.750	1.980	0.995	1.500
Lime	9.520	12.672	3.100	14.040
Magnesia	1.490	1.170	1.220	0.863
Alkalies	none.	none.	none.	none.
Sulphuric acid (anhydride)	trace.	0.170	trace.	0.152
Phosphoric acid (anhydride)	4.960	6.820	0.730	6.300
Volatile matter	22.065	27.244	14.933	15.009
Carbon Fixed	16.213	4.726	6.562	34.473
Water	0.700	0.300	2.588	0.717
	100.000	100.000	100.000	100.000
Ash, or Roasted ore	60.475	72.070	76.902	48.571

The important constituents of this Ash are shown below:

Metallic iron	33.032	39.593	14.645	23.619
Sulphur	0.839	0.800	0.319	0.360
Phosphorus	3.581	4.131	0.474	5.664

No. 1 is the lower stratum of blackband between the coal, about 18 inches thick; No. 3, the upper and earthy part of the same, 6 to 10 inches.

No. 2 is the seam, about 12 inches thick, lying above the coal and separated from it by 16 inches of fire clay. This is a hard, black, slaty ore, with occasional balls still more dense; No. 4 is the stratum, about 3 feet

above the coal, which consists of black, heavy, very tough, concretionary lumps of ore. The amount of phosphorus which these beds contain is very notable, and is, of course, due to their highly fossiliferous character; and yet no fossil bones, shells or identifiable organisms were visible. The high percentage of phosphorus excludes them from the manufacture of wrought iron till the introduction of some method effective in eliminating this injurious ingredient; otherwise these ores are well constituted for the manufacture of iron very cheaply, by mixing with other and purer ores from the neighborhood. It is not probable that the phosphatic character will follow the ore beds and appear at the other outcrops in the same force; it is a character likely to be local. These ores will make pig iron suitable for castings.

Outside of the line of outcrops of the coal, and within a few rods of it, is a bed of limonite belonging to the underlying shales. The thickness is 2 to 3 feet, and it is traceable for a considerable distance along the surface. Probably it is the result of the weathering of some of the argillaceous carbonates already described.

McIver Ore Bed.—A similar outcrop of a partly stripped bed has been noticed at a point $1\frac{1}{2}$ miles southeast of Egypt, on Pretty creek, known as the McIver ore bed. It is 20 inches thick, and carries a very slaty and somewhat shaly limonite, with occasional masses of ore of considerable size; it is obviously the result of the oxidation of one of the blackband or argillaceous carbonate seams already described, but its exact geological relations are concealed by vegetation and soil.

The analysis by Buck shows the following composition:

LIMONITE FROM THE McIVER ORE BED.	(27)
Metallic iron	47.59
Sulphur	0.14
Phosphorus	9.94

Evans Vein—This occurs about 6 miles north of the Gulf, on the Graham road. Its thickness is 6 feet. The ore is a non-crystalline jaspery hematite.

The country rock is talco-chloritic argillite, (Huronian), which in the hill a few hundred yards beyond becomes a sort of spotted slate conglomerate. Wilkes gives the following analysis by Schaeffer*:

HEMATITE FROM THE EVANS VEIN.	(28)
Peroxide of iron	96.4
Silica	2.1
Earthy matter	1.5

*Examination of Deep River Country, 1859, p. 14.

The ore is abundantly scattered over the surface of several acres, and Emmons traced the bed three-fourths of a mile. He also speaks of another vein of hematite*, (specular and crystalline), on the neighboring farm of Mr. Glass, which was revealed only by surface fragments; and also of "a magnetic ore of fine quality on the plantation of T. Unthanks, 2 or 3 miles beyond the Evans place," and of another of the same class at Heading's near Ore Hill. Still another locality is noticed by both Emmons† and Wilkes‡ as containing a bed of reddish-brown ore, which is magnetic. It is represented as 2½ feet thick at the Tyson Place, and as occurring at various other points. The analysis given by Wilkes‡ is as follows:

MAGNETIC ORE, TYSON PLACE, CHATHAM COUNTY.	(29)
Peroxide of iron	79.72
Carbon	7.37
Silica	4.
Water	8.80
Metallic iron	61.

Ore Hill Mine.—The most noted locality in Chatham County is known as Ore Hill.

The accompanying plate (plate V) shows the topography and general relations, and approximately the situations of the veins, which are numerous and lie at various angles with the meridian and with the horizon.

The rock is a talco-quartzose slate, knotted and toughened with much tremolite. The ore is limonite, with the exception of one vein near the top and back of the hill, which is hematite, partly specular, and much resembles the Evans ore.

The abundance of the scattered fragments would seem to indicate a vein of considerable extent. Most of the veins had been opened, but had subsequently fallen in, and accurate measurements could not be taken when the mine was visited. Still it was easy to see that two or three of them were very large—10 to 15 feet and upwards. The ore is spongy, porous, scoriaceous, botryoidal, mammillary, stalactitic, tabular, and of many other fantastic forms. The workmen stated that

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* Geology of Midland Counties of North Carolina, 1856, p. 122.

† Geology of Midland Counties of North Carolina, 1856, p. 262, *et seq.*

‡ Examination of Deep River Country, 1859, p. 15.

there were large cavities (vuggs) in some parts of the veins. The analyses here given are of samples from the 90 foot shaft, nearest the hematite vein, and may be considered as fairly representative:

HEMATITE FROM ORE HILL.	(30)	(31)
Silica	1.42	3.79
Alumina	....	....
Sesquioxide of iron	82.02	83.69
Peroxide of iron	....	0.11
Lime	1.19	....
Magnesia	0.11	....
Phosphoric acid (anhydride)	....	trace.
Sulphuric acid (anhydride)	....	0.77
Water	15.26	
	100.	
Metallic iron	57.26	58.67
Sulphur	....	0.33
Phosphorus	....	trace.

The first of these (30) was made by Dr. T. M. Chatard, for Prof. F. A. Genth, and the second (31) by Mr. Hanna.

This ore was worked on a considerable scale during the American Revolution, and again during the late civil war; and the iron is reported to have been of good quality. It is obviously an ore very readily smelted.

The presence of the hematite vein and the proximity of the ball ore, which was successfully used as a flux in the last working of the furnace, furnish admirable conditions for advantageous iron manufacture*.

Many other specimens have been sent to the Museum from various parts of the section: magnetite, hematite and limonite, representing veins and deposits of which nothing is known in detail. It is worth while to mention two of these specimens, one from Chatham county, between Lockville and Endor, and the other from the adjoining county of Moore, Governor's Creck, as they are almost the only examples of the species of ore called *jaspery clay iron stone* yet found in the State.

JASPERY CLAY IRON STONE.	(32)	
The former contains	48.92	per cent. of iron.
" " "	0.39	" " " phosphorus.

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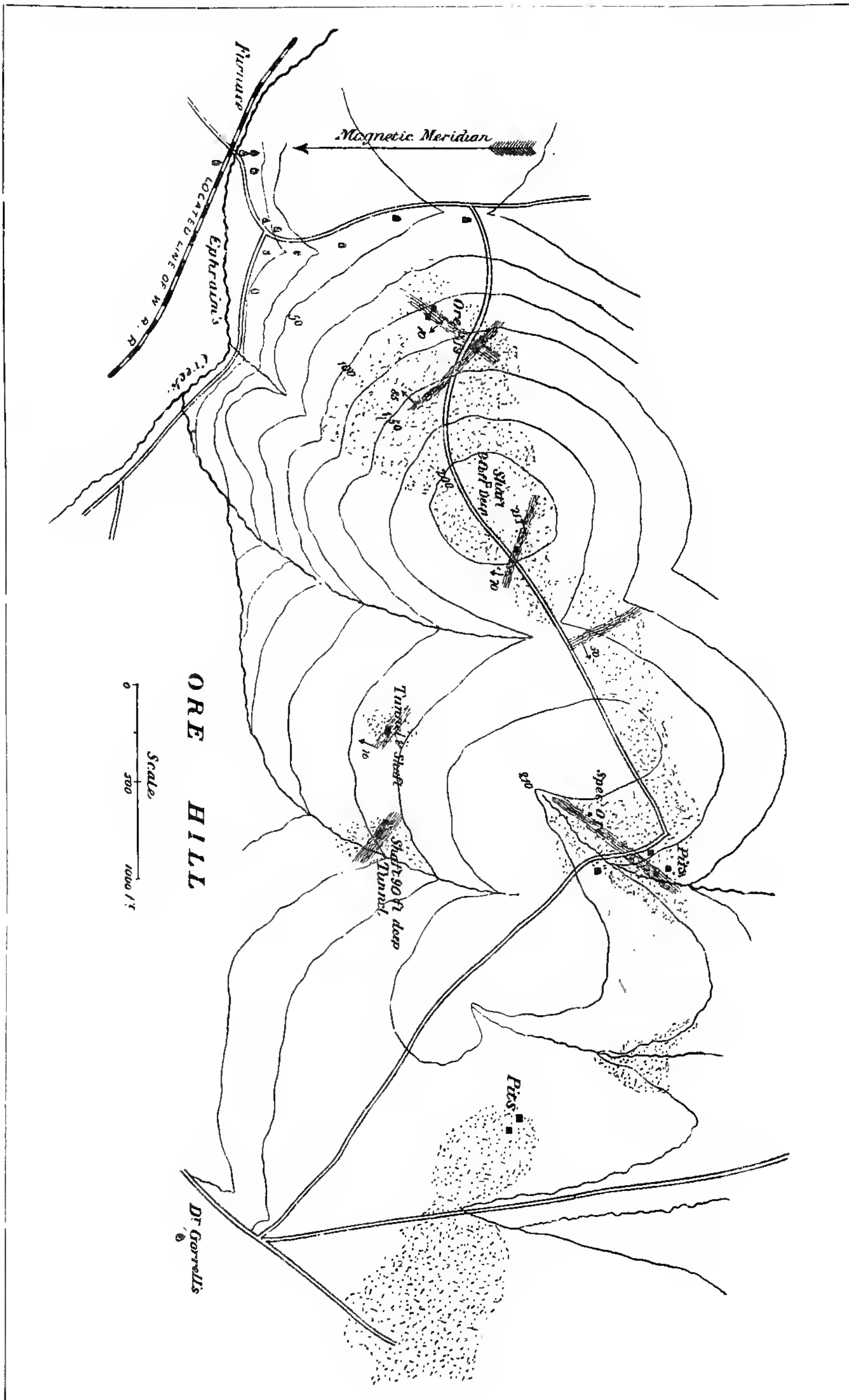
*The proposed Western Railroad located on the accompanying plate of Ore Hill has developed into the Cape Fear and Yadkin Valley Railroad, which now affords ample transportation facilities.


Magnetic Meridian
Furnace
Ephraim's Creek
ORE HILL
Scale
0
500
1000 ft
Tunnel & Shaft
Shaft 90 ft deep
Tunnel
Pits
Pits
Dr Gorrell's

Magnetite at Tyrrell's Mountain.—A fine quality of magnetic ore, dense metallic, and very pure, is found on the east side of Haw River, and about 2 miles distant, at the foot of Tyrrell's mountain, on the farm of Mr. Snipes. The vein has not been fully exposed, but it is reported to be 3 or 4 feet thick. It is in syenite, and has an epidotic gangue. The analysis by Lobdell is as follows:

MAGNETIC ORE FROM MR. SNIPES, TYRRELL'S MT.	(33)
Silica	1.62
Alumina	6.60
Magnetic oxide of iron	88.41
Manganese	0.56
Lime	trace.
Magnesia	0.85
Phosphoric acid (anhydride)	0.00
Sulphur	0.13
Metallic iron	63.49

Hematite on Collins' Creek.—A very fine micaceous hematite is found near the mouth of Collins' Creek, a few miles above, in Orange county. It has not been explored, but surface fragments are abundant.

Chapel Hill Iron Mine.—The most notable ore bank yet opened in this county, is that at Chapel Hill. It is a very dense, steel gray hematite, specular in part, with a slight percentage of magnetic oxide. The accompanying plate* (plate VI.) shows its relations. The vein is found on a hill one mile north of Chapel Hill, and more than 200 feet above the creek at its base. The rock is gray granite and syenite, but the vein is carried by a much jointed, fine grained, ferruginous, slaty quartzite of several rods in breadth, the iron-bearing part of it, the vein proper, being 7 to 10 feet at the main shaft, and suddenly enlarging near the summit of the hill, just beyond the second shaft, to 25 to 30 feet.

*The accompanying plate of the Chapel Hill Iron Mine, is a reproduction of that given in the Report for 1875, (Geology of North Carolina, Vol. I., 1875, p. 234), with the topographical features redrawn from a survey by Prof. W. B. Phillips.

The character of the ore is shown by the following analysis:

HEMATITE, CHAPEL HILL IRON MINE.	(34)
Silica	2.63
Alumina	1.68
Protoxide of iron	2.45
Sesquioxide of iron	91.24
Oxide of manganese	0.34
Lime	0.56
Magnesia	0.00
Phosphoric acid (anhydride)	0.04
Sulphur	0.11
	99.05
Metallic iron 65.77	

This ore is of notable purity, and the practical tests thus far applied have confirmed the indications of the analysis—that it is an ore of high grade; the quantity is very great. The vein, as shown in the section, (see plate VI) has a dip to the west at an angle, which is little short of 90°.

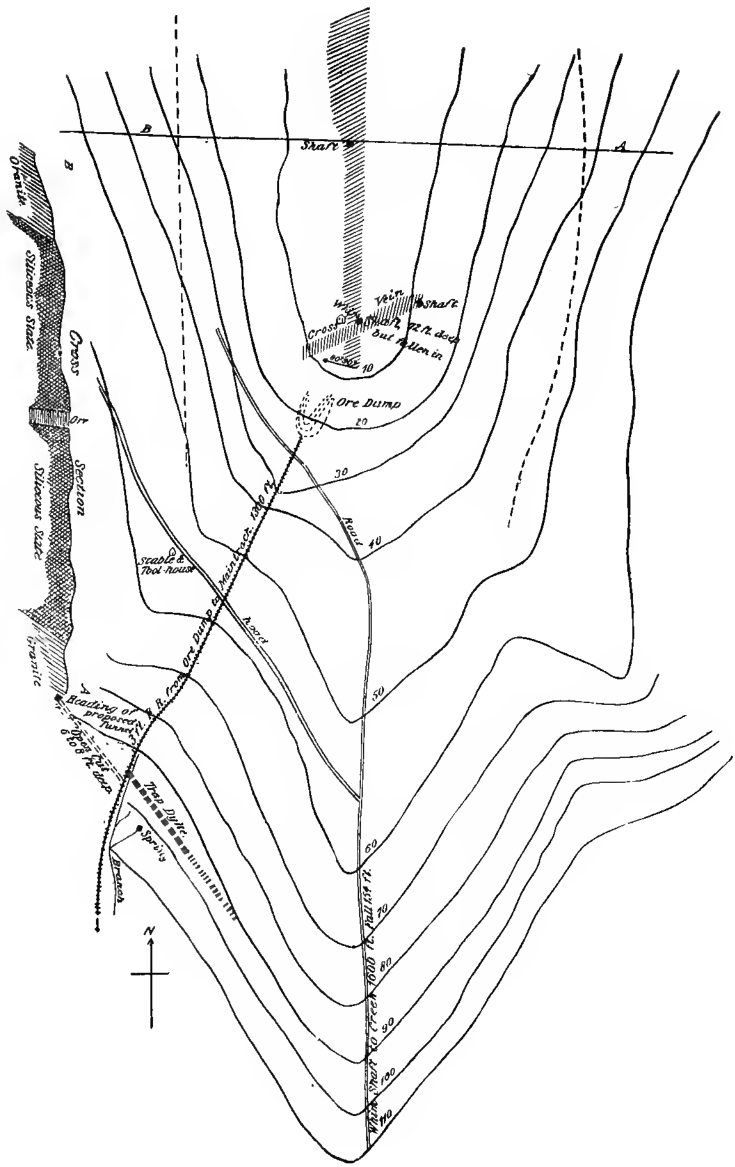
A second vein of the same character crosses the main vein near the first shaft, as shown in the plate. The ore becomes poorer as the vein is followed beyond the summit of the hill northward, till at the distance of 150 yards beyond the upper shaft, the quartzite predominates and the ore becomes poor.

This mine was operated on a small scale a few years ago,—at intervals from 1872 to 1882,—and several thousand tons of ore were removed. Work has been suspended for the present, but is to be resumed at an early date. The Chapel Hill Railroad passes near the mine, and is connected with it by means of a tramway.

There are surface indications on the neighboring hills, both north and south, for several miles, which show that this vein has a considerable extension; and, in fact, it may be considered as a continuation of the hematite veins of Deep River.

*Magnetite near Chapel Hill.**—Magnetite occurs about 3 miles S. S. E. of Chapel Hill, on the Cheek farm, in surface fragments, a few inches to one foot in diameter, scattered over a portion of an old field. No explorations have been made with view to determine the nature and extent of the deposit of ore.

* Journal of Elisha Mitchell Scientific Society, 1883-'84, p. 87.



CHAPEL HILL IRON MINE.

A topographical sketch, showing the relations of the ore deposit. Scale: 1 inch=200 feet.

Analysis of a specimen from one of these surface fragments made in the Chemical Laboratory at the State University gives the following:

MAGNETITE, CHEEK FARM, NEAR CHAPEL HILL.	(34 a)
Magnetic iron oxide	96.03
Silica	3.02
Water	.52
Sulphur	.19
Phosphorus	trace.

Magnetic and Hematite Ores near Hillsboro.—Five miles southeast of Hillsboro a vein of magnetite is traceable for one-fourth mile, and a considerable quantity of ore is reported as occurring on the surface.

Hematite is also found on the Hastings place; where blocks of ore are said to cover the surface for an acre or so in extent.

Deposits of hematite outcrop 3 to 4 miles W. S. W. of Hillsboro; and others are reported on Eno River ½ mile above railroad bridge west of Hillsboro, and further S. W. of Hillsboro, and a little to the northwest of Oaks. At the outcrop 3½ to 4 miles W. S. W. of Hillsboro, the ore is a fine grained hematite, much jointed, in wedge-shaped pockety masses, 4 feet and less in thickness, bedded in a ledge of bluish, shaly. jointed rock.

Another outcrop occurs along the top of a ridge ½ mile long, in an E. N. E. and W. S. W. course, about ¼ to ½ mile W. S. W. of the above, and about 4 to 4½ miles W. S. W. of Hillsboro. The ore here appears as a heavy ledge of fine grained, dark blue slaty hematite, which in places changes into quartzite schist, and in other places into a ferriferous, spotted, conglomerate, talcoid, slate, as near the Evans vein in Chatham county, which ore it resembles. The bodies of ore are irregularly distributed through the slaty ledge.

Other outcrops have been observed in this region, and hand specimens of very fine specular and magnetite ore have often been brought to the museum from many other parts of Orange county, but nothing is known of their quantity.

Magnetite on Knapp of Reeds creek, Durham County.—A magnetic ore makes its appearance in the northeast corner of Durham county, 3 miles beyond the upper fork of the Neuse River on Knapp of Reeds Creek, on the farm of Joseph Woods (1875). The rock here is clay slate, more or less chloritic or quartzitic, and thin bedded. The ore is slaty, and is, in fact, an impregnation of the chloritic

argillaceous quartzite with granular magnetite and hematite. The ore is very extensively scattered over a succession of hills, for about a mile, in a northeast direction; the ore bed outcrops at one point for a few rods, where it appears to be about 3 feet thick, and has a strike N. 40° E., and a dip at an angle of 70° to the northwest.

The bed seems to be duplicated towards the northeastern termination, another line of fragments marking the course of a parallel vein several rods to the east of the former. This last is associated with a bright vermilion red, and a banded, black and red jasper. Dr. Genth's analysis of the ore is as follows:

MAGNETITE FROM J. WOODS, KNAPP OF REEDS CREEK, DURHAM COUNTY.

	(35)
Silica	20.38
Magnetic oxide of iron	75.69
Magnesia	1.26
Phosphoric acid (anhydride)	0.05
Water, etc	2.62
Metallic iron	54.81

The analysis of another sample (by a different chemist) gave iron 56.50.

Hematite from Mt. Tirzah, Person County.—At Mt. Tirzah, in the southeastern corner of Person, near the Durham county line, there is a vein of hematite (specular), from which iron was made to some extent during the late war. It is described as about 6 feet thick. The specimens sent to the museum resemble the ore of the Buckhorn mine.

The Ores of Montgomery and Randolph belong geologically to the Chatham range, for they are found in the same great slate belt (Huronian) that constitutes both geologically and mineralogically the most notable feature of the middle region of the State. The best known of these ores is found near Franklinville, Randolph county, and is reported to be largely magnetic.* Another vein, near Ashboro, carries specular hematite. Some of the strongest and most highly prized iron obtained during the war came from this locality.

Dr. Emmons* describes an occurrence of hematite of apparently considerable extent, 7 miles southwest of Troy, in Montgomery county.

* Geology of Midland Counties of North Carolina, 1856, pp. 118 and 119.

He says it is free from sulphur and a very pure ore. Another occurrence of magnetic ore is noted by him 4 miles north of Troy.* It is found with talcose schist ("slate"), is soft and friable; and it sometimes happens that a vein of specular ore lies by the side of a magnetic vein, being separated by only a few feet."

Iron Ores in Moore County.—Oolitic iron ore occurs at Brown's Mine one-half mile south of railroad, and 3 miles north of Sanford, Moore county.

A bed of ore, in sandstone, is found 1½ miles northeast of Sanford; it is reported to be 18 to 20 inches thick; strike N. 90° E.; dip 25° to 30° S.

Iron Ores of Guilford and Adjacent Counties.†

One of the most remarkable and persistent ranges of iron ore in the State crosses the county of Guilford in a northeast and southwest direction, passing about 10 miles northwest of Greensboro, near Friendship. It extends from the headwaters of Abbott's Creek, in Davidson county, entirely across Guilford to Haw River, in Rockingham county, a distance of 30 miles, making its appearance on nearly every plantation, and indeed almost every hill side in the range. The ore is a granular magnetite, and is everywhere titaniferous. It is usually rather coarse grained, and frequently associated with crystals of chlorite in small seams and scattered bunches. The ore is in the form of beds, which partake of all the foldings and fractures and irregularities of bedding to be expected in a region where only the oldest metamorphic rocks are found. The deposits lie along and just west of the line of junction of what has been provisionally set down as the lower and upper Laurentian series of granitic rocks, as marked on the geological map accompanying this volume.

There is a second, but much more interrupted range of ore parallel to the one just described, and lying a few miles to the northwest. I visited this region in 1871, in company with Dr. F. A. Genth, at that time chemist and mineralogist to the Survey. The entire range was taken into the tour, and samples carefully made from many points by Dr. Genth, in order to ascertain the average character, and to bring out the

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* Geology of Midland Counties of North Carolina, 1856, pp. 118 and 119.

† Reprinted with slight alterations from Prof. Kerr's Report of 1875. (Geology of North Carolina, 1875, p. 236 *et seq.*)—G. B. H.

local peculiarities of the beds. The beds had recently been extensively opened by means of trenches, so that the general features of the deposits were well exposed. Dr. J. P. Lesley, now the Director of the Pennsylvania Geological Survey, had just prior to this made a very careful study of the entire range in all its bearings. Some of the more important points of his results are here given. Whatever is found below on the subject of this range of ores in quotation marks, is taken from his report,† unless it be otherwise stated.

"This part of North Carolina is occupied by some of the oldest rocks "known—the same rocks which hold the iron ore beds of Harford county, "Maryland, and Chester county, Pennsylvania, and the gold ores of "Georgia, North Carolina, Virginia and Canada. The gold mines of "Guilford county, N. C., are opened alongside of, and not more than 10 "or 12 miles distant from the Tuscarora Iron Belt. Both the gold and "iron range continuously, (with one break in New Jersey,) all the way "from Quebec, in Canada, to Montgomery, Ala. The gold and iron "bearing rocks are: granites, gneissoid, sandstones and mica slates, all "very much weathered or decomposed, and that to a depth of many "fathoms beneath the present surface. The solid granites are decom- "posed least, the mica slates most. All contain iron, which has been "peroxidized and hydrated, in the process of decomposition of the "whole formation, and dyes the country soil with a deep red tint. The "surface of the country is a smooth, soft, undulating plain, broken by "gentle vales, the bottom of which are never more than 100 feet below "the plain, and commonly not more than half that depth."

The local relations and geography of the ore belts are shown in the accompanying map (plate VII).*

The two accompanying maps (plates VIII and IX) show the ore belt on a larger scale, giving the names of the plantations crossed by the ranges, with a scale of miles, which commences at the southwest extremity of the beds on a branch of Deep River. It will be seen that the length of the outcrops, air line measure, is 28 miles.

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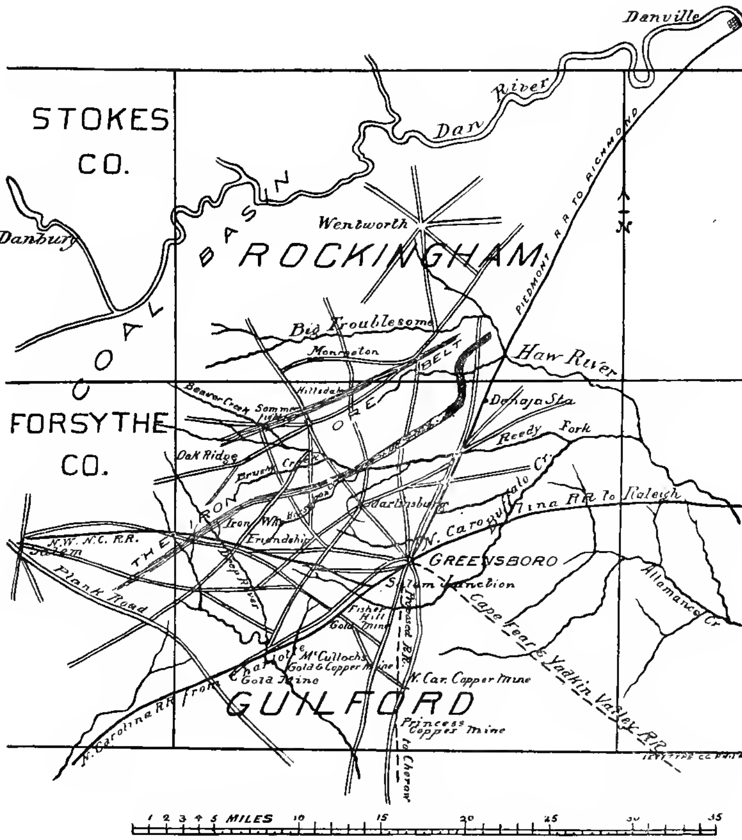
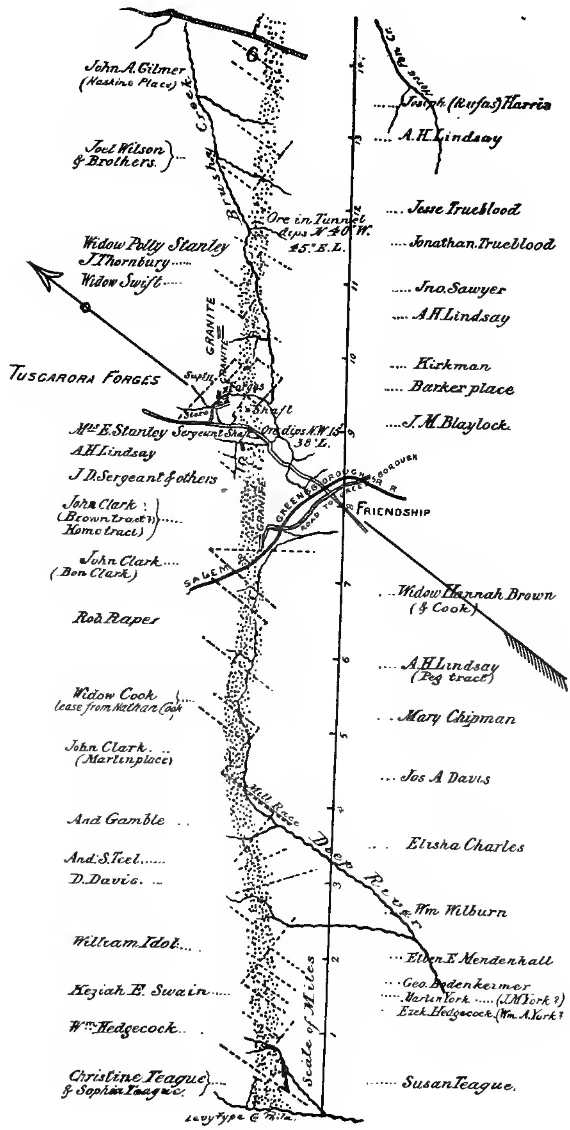
† Note on the Titaniferous Iron Ore Belt near Greenboro, North Carolina. Am. Phil. Soc. Proc., Vol. XII, p. 139, read June 16, 1871.—G. B. H.

* The plates for the accompanying illustrations of the Guilford ore beds have been reproduced from the illustrations published in Prof. Lesley's original report (see note above), and republished in the Geology of North Carolina, 1875.

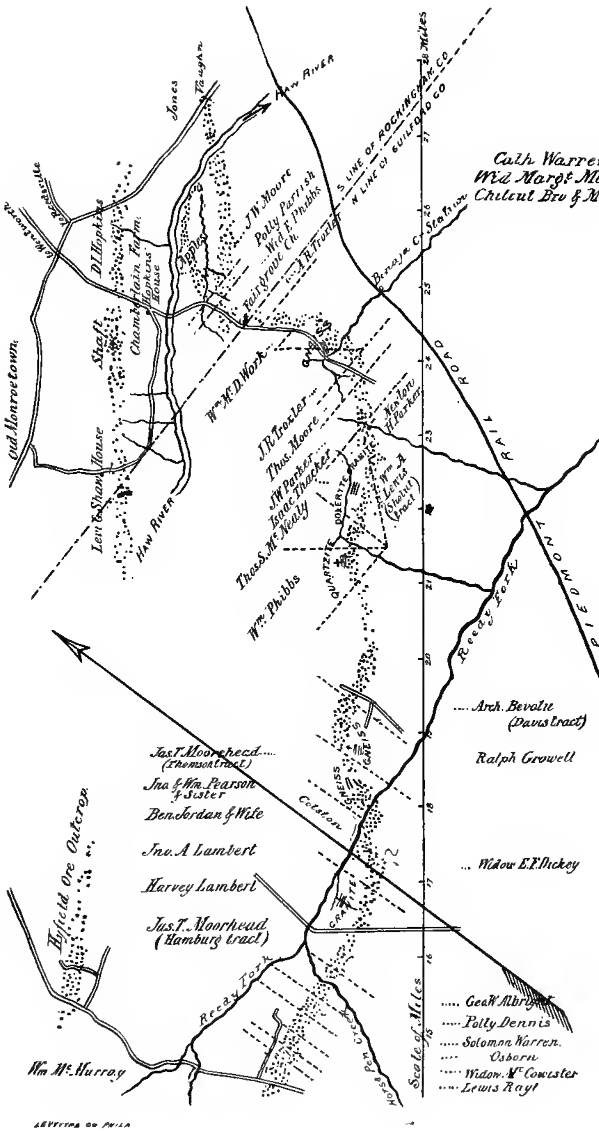


IRON ORE BELTS OF GUILFORD COUNTY.
A sketch map showing the relations of the ore deposits. (After LESLEY.)



IRON ORE BELT OF GUILFORD COUNTY.

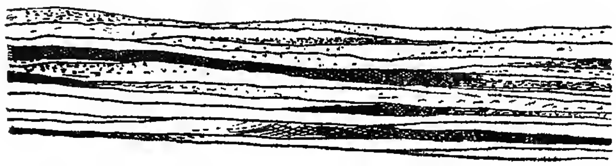
A map showing the southern half of the ore belt, on a scale much larger than that of Plate VII. (After LESLEY.)



IRON ORE BELT OF GUILFORD COUNTY.

A map of the northern half of the ore belt, on a scale much larger than that of Plate VII. (After LESLEY.)

The mode of occurrence in *beds* is illustrated by Dr. Lesley, by means of the following ideal diagram:



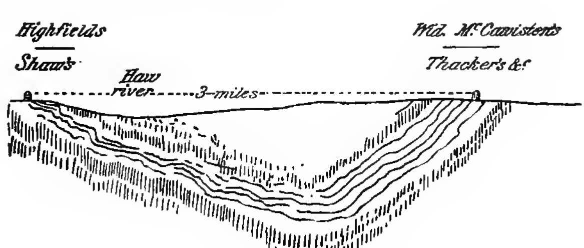
"The beds were deposited, like the rest of the rocks, in water; depos-"ited in the same age with the rocks which hold them,—are in fact "rock-deposits highly charged with iron, and they differ from the rest "of the rocks only in this respect—that they are *more highly charged* "*with iron.* In fact all our primary (magnetic and other) iron ore beds "obey this law.

"They are merely certain strata consisting more or less completely "of peroxide of iron, with more or less intermixture of sand and mud, "which, when crystallized, fall into the shape of felspar, hornblende, "mica, quartz, etc., etc.

"The belt of outcrops of ore-bearing rocks has a uniform breadth of "several hundred yards, and I believe a uniform dip towards the north-"west or north-northwest.

"The map, however, shows *another ore belt,* running parallel with "the former and at a distance of three miles from it. This is called "Highfield or Shaw outcrop. Beyond Haw River these two belts ap-"proach each other, and are believed to unite in Rockingham county. "This and other considerations make it almost certain that the Shaw "belt is the northwest outcrop of a synclinal basin, 3 miles wide, and "that the Tuscarora belt is the southeast outcrop.

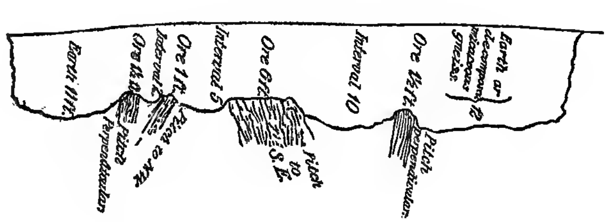
"If so, the Tuscarora ore-beds descend with a northwest dip to a "depth of a mile beneath the surface, and then rise again as ore-beds "at Highfield's and Shaw's, thus:



"The locality of the ore-beds is indicated by the occurrence of frag- "ments of ore scattered over the surface, and there are indications by "which nearly all iron ore deposits are discovered. Large pieces on "the surface are the best evidence we can possess that the beds are of "good size, for they have come from those portions of the beds which "have been destroyed in the general lowering of the surface of the "country. There is no reason why the parts of the beds left under the "present surface should not yield as large masses as the parts which "have mouldered away."

As will be readily understood from what has been stated above, the number of ore beds in the cross-section will be likely to vary from point to point along the range. "A large number of rock strata will "become ore-beds locally. But there will always be a particular part "of the formation more generally and extensively charged with great "quantities of iron than the rest. In other words, the iron of the "formation, as a whole, is concentrated along one or more lines. This "is evidently the case with the Tuscarora Ore Belt, as is shown in the "almost perfect straightness of the outcrop of the Sergeant shaft ore "bed, when its outcrop has been opened for half a mile northeast of "the shaft. There are two principal beds cropping out on the Teague "plantation, at the (southwest) end of the belt, both vertical, about 300 "yards asunder."

And not only does the number of ore beds vary, but they are often very irregular in position. This is illustrated by the following section, revealed in a "trench, cut at right angles to the outcrop, fifty feet long and four to eight feet deep." It is on the widow McCawisten's plantation.

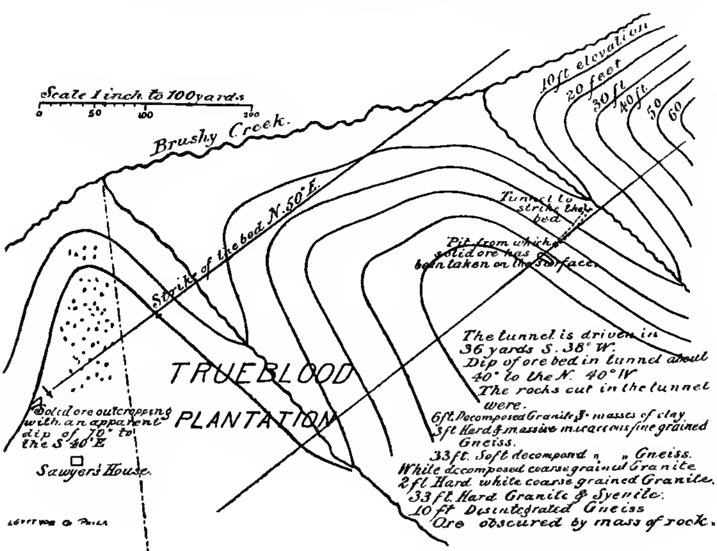


"Similar irregularities are noticeable everywhere. The miners say "that the pitch of the outcrop of the ore bed, worked in the Sergeant "tunnel and shaft, was southeast for some way down, after which it "took its regular northwest dip, such as it now has in the shaft and

"tunnel at the depth of 100 feet. Besides which, there are in fact two "beds cut in this shaft-tunnel, the smaller bed underlying the other, "and with a dip which would carry the two beds together at some "distance beneath the floor.

"Another instance occurs on the Trueblood plantation, where the "two ore-beds appear to be only 200 yards apart at their outcrops, and "seem to dip different ways, which I explain by reference to the false "surface dip of the Sergeant shaft and bed. The Trueblood section is "as follows:"

Plan of the outcrops & diggings on the Trueblood Plantation



The sections made at the Shaw plantation (Shaw range), furnish a further illustration of these irregularities. "The ore bed is full six feet "across, solid ore, a very green, chloritic mica slate, rock-ore. In this "run of 800 yards, there are *apparently two hundred thousand* (200,000) "*tons above water level*, in the one 6 foot bed. The outcrop runs along the "top of a hill about 100 feet above the bottom of Haw River valley. "There are apparent variations in the dip, some of the outcrops seem-"ing to be vertical, whereas the principal part of the mining has "already shown a distinct dip towards the southeast and south."

The average dip of the ore beds of this second range was observed

by Dr. Lesley to be considerably less than that of the Tuscarora beds, as is shown in the section, p. 145.

The *quantity of ore* which this remarkable range is capable of yielding is immense. The number and extent of the beds have been noted; their size varies greatly, as is shown in several of the diagrams. "They "consist of strings of lens-shaped* masses, continually enlarging and "contracting in thickness, from a few inches to 6 and 8 feet. The "principal beds may be safely estimated on an average of four feet, "and in the best mining localities, the average yield of a long gang-"way may reach five feet. It is certain that centuries of heavy min-"ing could not exhaust it, for each of two or three principal beds may "be entered and mined at fifty places."

The kind of ore has been stated in general terms as titaniferous magnetite. More particularly, not only titanium, but chromium and manganese are uniformly present, as will be seen from Dr Genth's analyses, given below. "The ore belongs to the family of primary "ores, the same family to which the Champlain (or Adirondack) ores, "the Marquette (Lake Superior) ores, and the ore of the Iron Moun-"tain in Missouri belong. It is very similar to the New Jersey ores, "which are so extensively mined for the furnaces on the Lehigh river.

"It is a mixture of magnetic crystals and specular plates of sesqui-"oxide of iron, with quartz, felspar and mica, in a thousand varying "proportions. Sometimes the bed will be composed of heavy, tight, "massive magnetite (or titaniferous magnetite), with very little quartz, "&c.; at other times, of a loose, half-decomposed mica-slate, or gneiss "rock, full of scattered crystals of magnetic iron. The ore is, in fact, "a decomposable gneiss rock, with a varying percentage of titaniferous "magnetic and specular iron ore, sometimes constituting half the mass, "and sometimes the whole of it."

Dr. Genth, who made a special chemical and mineralogical study of these ores, says in his report, published in the *Mining Register*: "All "the ores consist of mixtures of magnetic iron with titaniferous hem-"atite, or menaccanite, probably also with rutile (titanic acid), mixed "with a chloritic mineral, or a silvery micaceous one resulting from its "decomposition. Some of the ores contain alumina in the form of "granular corundum, in one or two places in such quantities that they "become true emery ores. None of the constituents could be separated

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* For a further description of this peculiarity, see the account of the Lincoln, Gaston and Catawba Ore Beds.

"in a state of such purity that in all cases their true mineralogical "character could be verified by analysis.".

But besides the characteristic ores of the beds described, Dr. Lesley mentions beds of ochre of various sizes, "as one of the constituent "elements of the whole formation."

"What the exact relationship is of these ochre beds to the magnetic "ore beds, I do not know, but the ochre outcrop seems to be always in "the immediate vicinity of the ore beds; the largest exhibition of ochre "which I saw, is on the plantation of I. Somers, on Brushy Creek. Here "an ochre bed twenty feet thick rises, nearly vertical, out of a gully in "a hillside covered with small pieces of fine compact ore. The whole "aspect of this place gives an impression of an abundance of ore be- "neath the surface, but no openings on the beds which have furnished "these fragments have been made."

The following table presents the analyses of sixteen samples, collected, as previously stated (p. 143) by Dr. Genth, along the entire length of this range of ore beds in 1871:

IRON ORES FROM THE TITANIFEROUS BELT OF GUILFORD AND ADJACENT COUNTIES.

	(36)	(37)	(38)	(39)	(40)	(41)	(42)
Silicic acid	0.76	5.68	0.40	1.84	1.30	1.31	12.75
Titanic acid	13.52	11.67	11.95	13.28	12.35	13.60	15.35
Magnetic oxide of iron	79.53	72.74	81.89	77.62	77.90	76.04	57.93
Oxide manganese and cobalt	0.81	0.64	1.02	0.95	1.10	0.96	1.15
Oxide chromium	0.46	0.48	1.07	0.65	1.10	0.72	1.25
Alumina	1.68	5.08	1.06	2.30	2.54	4.26	5.17
Magnesia	2.79	2.61	1.99	2.01	2.41	2.33	4.14
Lime	0.45	0.76	0.24	0.58	0.51	0.60	0.90
Water	......	0.34	0.38	0.77	0.79	0.18	1.36
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Metallic iron	57.68	52.68	59.03	56.21	56.41	55.06	41.95

IRON ORES FROM THE TITANIFEROUS BELT OF GUILFORD, ETC.—*Continued.*

	(43)	(44)	(45)	(46)	(47)	(48)	(49)
Silicic acid	1.30	26.80	0.50	1.80	0.74	1.39	0.98
Titanic acid	1.27	16.20	12.27	14.46	13.92	0.78	2.42
Magnetic oxide of iron	93.63	30.90	79.16	74.80	76.80	42.77	46.29
Oxide manganese and cobalt	0.93	1.55	1.21	1.53	1.30	1.00	1.27
Oxide chromium	1.43	0.43	0.57	0.97	1.07	0.30	trace.
Alumina	0.55	8.87	3.62	2.66	3.82	52.24	44.86
Magnesia	0.75	10.30	2.04	3.09	1.80	0.68	3.27
Lime	0.14	0.40	0.63	0.69	0.55	0.84	0.91
Water		3.55	......	......	......	......	......
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Metallic iron	67.60	21.63	57.32	54.17	55.61	30.97	33.52

The following are Dr. Genth's notes, in part:

"Nos. 36 and 37, K. R. Swain's, Davidson county. The ores on "this place are both massive and granular magnetite, with small ad- "mixtures of greenish chlorite, mostly between the fracture planes, "partly altered to the above-mentioned silvery white or brownish-white "micaceous mineral, and in those in which the latter forms a conspic- "uous constituent; 36 represents the massive ore, 37 the micaceous.

"No. 38, Elisha Charles', Guilford county. The ore is granular, "iron-black, with small quantities of the silvery micaceous mineral.

"No. 39, widow Cook's. The ore is similar to the last, but a little "more chloritic and micaceous in little patches throughout the mass.

"No. 40, John Clark's. The ore resembles that from the widow "Cook's plantation.

"No. 41, widow Stanly's, Sergeant Shaft. The ore is compact, gran- "ular, iron-black; it shows rarely octahedral crystals of magnetite, and "is associated with dark green, foliated chlorite, especially on the frac- "ture planes.

"Nos. 42, 43, and 44, widow McCawisten. The greatest variety of "ores exist at this plantation. They are peculiar, but highly interest- "ing and important. No. 42 is the soft micaceous ore; 43 the mag- "netic portion of 42; 44 the non-magnetic portion.

"No. 45, W A. Lewis'. Very fine granular ore, with very little ad-"mixture of chlorite.

"No. 46, Levi G. Shaw's, Rockingham county. Fine-grained, black, "slightly micaceous; shows a somewhat stratified structure.

"No. 47, P. Hopkins' (Alcorn Farm), Rockingham. Very fine-"grained, black, fragile ore, with little admixture of foreign substances.

"No. 48, Granular, reddish ore. It has much the appearance of a "granular reddish-brown garnet, for which it has been mistaken; but "the analysis proved it to be not a silicate mixed with granular mag-"netite, but *corundum*.

"If this and the next should be found in quantity, they would be "of considerable value, as a good quality of *emery*.

"No. 49, Granular grayish ore. This is of a similar quality, and is "found at the same locality; the minute grains of corundum have a "yellowish or brownish-white color, and show in many places cleavage "fractures, which give it the appearance of a feldspathic mineral.

"From these analyses, it is seen that the average of the ten speci-"mens of original iron ore, which represents the whole range for a "distance of nearly 30 miles, is:

AVERAGE OF GUILFORD ORES.	(50)
Iron	54.61 per cent.
Titanium	8.07 " "
Titanic acid	13.24 " "

"The ratio of titanium to iron is, 1: 6.77.

"All the ores were examined for sulphur and phosphorus, and were "found to be entirely free from these substances."

As there seems to be an unfavorable impression of the titaniferous ores in some quarters, it is worth while to quote Dr. Lesley on the effect of titanic acid in iron ores, as there is no higher authority in this country:

"This kind is difficult to smelt in the high-stack blast furnaces, but "makes the best iron in the world, when smelted in the Catalan Forge, "and is of great value for the lining of puddling furnaces. It serves "the same purpose as the Lake Superior ore, which is brought in large "quantities to Pittsburgh and the surrounding districts of Eastern "Ohio and Western Pennsylvania, for lining puddling furnaces, and to "mix with poorer ores in the blast furnaces.

"The titaniferous magnetic ores of the Ottawa region, in Canada,

"are also brought by a long and expensive route to Pittsburgh, to mix "with the Pennsylvania ores. These Canada ores are of the same geo- "logical age, and of the same mineral character as the Tuscarora ores "under consideration.

"The trial of this ore has been made by Nathan Rowland, Esq., at "his work in Kensington. Mr. Rowland expressed his opinion that it "stood up three times as long as the Champlain ore, which he used for "that purpose. This difference is due to the superior compactness of "titaniferous magnetite, over that of pure crystalline magnetite."

Dr. Lesley also says that these ores are "essentially like those of New "Jersey, as to age, situation, consistency and general composition," but unlike in this titaniferous quality. "The New Jersey ores seldom pos- "sess this property, and in any case only in a low degree. The Can- "ada ores and the ores of South Sweden hold large quantities of titanic "acid—as much as 30 and 40 per cent. sometimes.

"A very minute quantity of titanium in pig iron, is believed to add "greatly to its value, increasing its hardness and firmness, and its abil- "ity to stand wear; the Canadian ores were introduced to the Pitts- "burgh works for this end."

These titaniferous ores require a higher heat in the stack to reduce, than pure oxide of iron; but they labor under another disadvantage, of suffering a loss of iron in the process of smelting, since the "only "solvents of titanic iron are the double silicates of *iron* and lime, or "*iron* and alumina and lime, or *iron*, potash and lime, etc.," and of course the more the titanic acid, the greater the waste of iron in the slag. These Guilford ores "have the advantage that they contain less "than 14 per cent. on the average, while the Canada ores hold 25 to "35 per cent. of titanic acid," and at the same time "they have all the "advantage which the presence of titanium affords: 1st, making the "ore so firm that it is the best possible lining for the puddling fur- "naces: 2d, making the iron tougher and harder, like the best Swed- "ish iron, and 3d, imparting a certain quality which adapts the iron "especially to the manufacture of steel. There is no question that "titanium in iron ore favors the production of iron peculiarly suited "to conversion into steel.

Dr. Lesley refers also to the fact that the ochre-beds, already described as accompanying the iron ore range (p. 148), furnish a superior flux for these ores. An analysis of "this ochre, which forms large beds

"on the outcrops of the more ferruginous feldspathic rocks," by A. A. Fesquet, gives the following:

OCHRE, GUILFORD ORE BELT.	(51)
Sesquioxide of iron	19.43
Silica	34.12
Alumina	33.21
Water, etc., etc	13.24

I add a few of Dr. Lesley's general conclusions as to the quality, quantity and value of these ores:

"The quality of the ore is first-rate—none better in the world.

"The soft ores will smelt easily and make malleable iron, tough and "strong.

"The hard ores will command extended use for puddler's linings, "and be in demand for mixing with poorer ores of other regions, and "for the manufacture of steel.

"The quantity of ore is limitless.

"The geology is all right, the mineralogy is all right, labor abundant and cheap;" the range is crossed by two lines of railroad, and portions of it lie within 5 miles of a third.

"Another probable advantage is the proximity of the Dan River "coal; although no satisfactory exposures have been made, yet there "are good reasons for believing that it is both abundant and of good "quality."

The views of Dr. Lesley are here presented at length, since being from another State his opinions may be supposed to have been expressed without bias, but they are especially quoted because of his eminence in everything connected with the geology, mineralogy and metallurgy of iron.

Any one who has the least knowledge of the present drift of the iron industry, and of the great importance of high grade ores, will understand the high value of such deposits as those just described in Guilford, Harnett, Chatham and Orange, etc. For the manufacture of common qualities of iron, England has unequalled advantages in her wonderful beds of fossil ores, her clay iron stones, and black band, which are mined in unlimited quantities from the same pit as the coal which is used to smelt them. But for ores of the better class adapted to the Bessemer and other processes of steel making, and for the better kinds of iron, she is confessedly dependent in a large measure on other countries.

The Guilford range of ores has not been traced to its termination in either direction. There are indications that there are beds of the same kind of ore as far northeast as Caswell county, some very fine specimens of magnetite having been brought to the museum from that county.

Hematite in Rockingham County.—There are also iron ore localities in Rockingham, which do not belong to the above range; for example, near the Virginia line, in a northeast direction from Madison, and again, two miles below the mouth of Smith's river, (Morehead's Factory), there is a bed of red hematite iron ore, about ten inches thick at the outcrop; it is dense, hard, uncrystalline and almost jaspery, and is apparently a good ore.

IRON ORES OF MECKLENBURG AND CABARRUS.

No iron mines of any extent have been worked in these counties, but ore has been found in a number of localities. Hand specimens of great purity are frequently brought to the Museum. Fragments of a very heavy black metallic ore are found in considerable quantity on the farm of Mr. George Phifer, three miles from Concord; the search for it was not sufficiently extended to allow of any satisfactory conclusion; the ore found, however, was of the best quality. Iron ore is found at Van Pelts, three miles from Davidson College, also hematite at a point five miles S. W. of the college. Some explorations were also made in the southern part of Mecklenburg, at the same time, in the Sugar Creek neighborhood; many blocks of a remarkably pure granular magnetic ore were found scattered over several acres of surface of an old field, and along the public road; several trenches were cut, which exposed two or three veins from one to four feet thick.* Some twelve miles northwest of Charlotte, in the Hopewell neighborhood, a notable quantity of surface fragments of large size are still to be found in an old field and in the wood adjacent. This is a specular ore in a gangue of quartzite, not unlike the Chapel Hill ore. No exposures of the vein were ever attempted. Beautiful pieces of micaceous hematite are found

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*NOTE.—S.W. Reid, Esq., informs me that iron ore has been found and prospected for to some extent on the land of Dr. Strong, Steel Creek Township, Mecklenburg county, and that on the lands of Mr. James Coffey, near by, a similar deposit was unearthed, and a considerable amount of ore raised.—G. B. H.

in almost every part of the county, but as yet there is no proof of any workable deposits.

Magnetite is also found on the ridge near the Frazer gold mine, five miles from Charlotte, west.

The ores of the southern end of this county and of Cabarrus, are found in the syenite, so prevalent in this region.

Iron Ores of Gaston, Lincoln and Catawba Counties.*

In these counties is one of the most extensive ore ranges in the State. It is also the best known, and best developed, and has been the principal source of our domestic supplies of iron for a hundred years. Some of the furnaces of the region were put in blast during the Revolutionary war. The ores are both magnetic and hematitic, and are found in the belt of talcose and quartzitic schist (supposed Huronian), called sometimes the "King's Mountain slates." This body of schists gradually narrows towards the northeast, and comes to a sharp point in Iredell county, 3 or 4 miles northeast of the Catawba River. To the south it extends far into South Carolina.

The range naturally divides itself into two sections—the northern in Lincoln and Catawba counties, and the southern in Gaston county, and the adjoining county of Spartanburg in South Carolina.

There is an intervening stretch of territory of 12 or 15 miles in the southern part of Lincoln and the northern part of Gaston, which is for the most part destitute of iron, unless it may have escaped observation by being covered up.

A similar body of schists is found to the northeast, beginning in Yadkin county two miles southeast of the Yadkin River. It gradually widens and finds a large development in Surry and Stokes counties. If any important bodies of this series occur in Iredell, Davie and the southern part of Yadkin counties, they have not been detected; though it is probable that there are small patches, which have escaped the denuding influences.

Of the occurrence of iron mines in this denuded area of 45 or 50 miles in length, very little can be said with certainty. It must be

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* The following pages describing the ores of Gaston, Lincoln and Catawba counties have been rewritten and much new matter added by the present writer.

The locations of the ore beds described as occurring in these counties are shown on the accompanying map, plate X. Only approximate accuracy is claimed for the map, but this much is claimed for it, as no detail survey of the region has been made.—G. B. H.

admitted that the upper part of Iredell, and the whole of Davie have never been carefully explored either by geologists or practical miners, and it cannot be confidently asserted that iron ores in workable quantities are lacking. This area will be alluded to again in the discussion of the ores of Yadkin county.

The direction of this range of ore-beds is coincident with the strike of the schists, and is about north-northeast from the west side of King's Mountain, on the South Carolina border, to the Catawba River in Catawba county. The ore beds occur with well-marked characters and associations, as do also the geological horizons, which are connected with them. So striking and persistent, indeed, were these peculiarities that they early forced themselves into notice as practical guides in the search for ore, fire-proof material and fluxes. The summary of Professor Emmons may, from its exactness and comprehensiveness, be properly introduced here.* This belt " immediately adjoins or belongs " to the belt of sediments which have been described as passing near " Lincolnton. At Lincolnton the rock is mostly a coarse light gray " micaceous granite. Beds of slate, limestone and quartzite, succeed it " on the east; but between this and the gneiss, a little further east, are " the veins of magnetic ore. The position of the narrow belt of talcose " slate, in which the ore occurs, is below or behind the heavy masses of " granular quartz. These masses of quartz, as they are continuous " from the South Carolina line to the Catawba, are land-marks for the " position of the ore.

" There is no ore above (to the west of) the quartzite, and I do not " know that there is any in the gneiss represented as below (to the east " of) the veins of iron in the section referred to.†

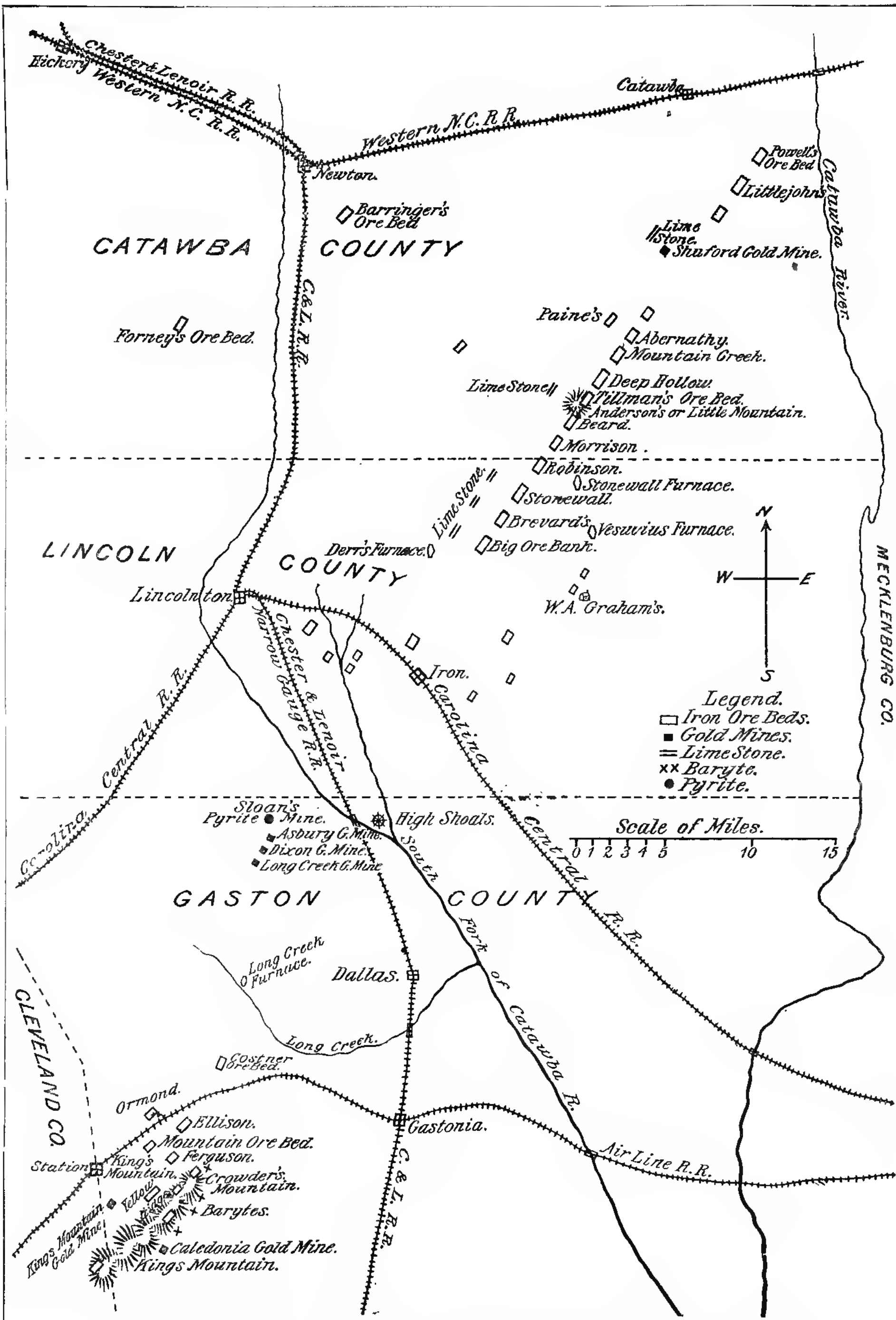
" The careful consideration, therefore, of such relations is of great " importance; they furnish a clue to the actual position of the veins.

" The rocks and ore taken in masses stand in this order, beginning " our reckoning on the west:

1. Slate.	2. Limestone.	3. Fire stone (itacolumitic sandstone.)	4. Quartzite.	5. Slates.	6. Magnetic ore.	7. Ferruginous slates.	8. Gneiss.	9. Granite.

* Emmons' Geological Report of Midland Counties of North Carolina, 1856, p. 113.

† There is some doubt of the correctness of this statement as to the non-occurrence of iron ore veins above the quartz (the dip of the bodies is towards the west), and it is now *known* that some are found below (east of) the gneiss, e. g., a vein of magnetic ore near the residence of Maj. W. A. Graham. G. B. H.



IRON DEPOSITS OF GASTON, LINCOLN AND CATAWBA COUNTIES.

"The quartz being a rock easily distinguished, becomes a guide to "the position of the ore. The limestone is usually west of the beds of "ore. The ore is usually near the crest of a ridge.

"The direction of bearing, as determined by the harder masses of "rock, is N. 20° E."*

The ores are mostly of a schistose structure, and commonly rather friable; in fact they may be described as magnetic and specular schists, being talcose, chloritic, quartzitic or actinolitic schists impregnated with granular magnetite and hematite (itabyrite). The beds are nearly vertical, and dip sometimes to the east and sometimes to the west, but the westerly dips are by far the most frequent. The general range of the beds is accompanied and indicated by a line of quartz ore, slaty ridges or knobs, the quartzite lying usually to the west of the ore beds, but occasionally to the east, and sometimes on both sides or even within the ore masses.

For a considerable part of the belt in Lincoln county, there are two parallel beds, the more westerly being the larger and more productive; the combined thicknesses being from 4 (rarely so low as 2) to 12 feet; the interval between them of 12 to 20 feet being occupied by talcose and chloritic schist, with a little ore in layers.† The occurrence of talcose schist ("slate") is commonly regarded as an unfailing sign of the proximity of ore.

The beds generally occur in lenticular masses or flattish discs, which

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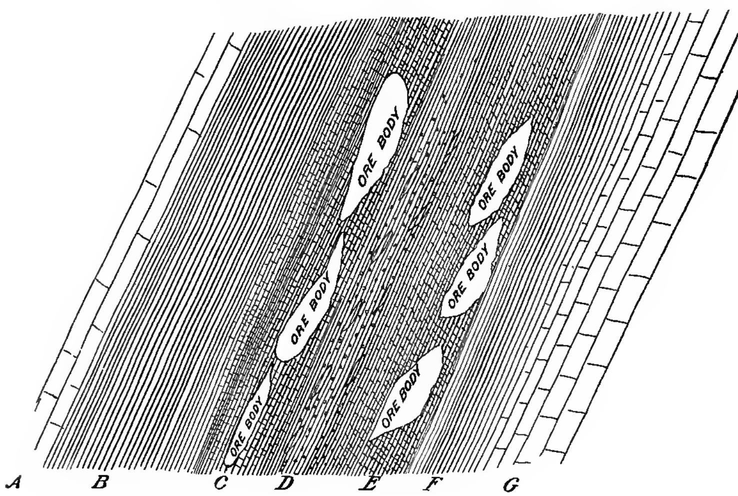
* It may be doubted if this indicates the bearing exactly for long distances, for the coast survey maps make the bearing of prominent points in these horizons fully N. 25° E. from each other.—G. B. H.

† Note.—It has seemed difficult to resist the conviction that this iron was deposited simultaneously with the formation of the original sedimentary beds, and with this view apparently both Prof. Kerr (above) and Prof. Lesley (p. 145) agree; but there are many facts to be noted of these mineral occurrences, which point with more or less force to some other origin connected with the metamorphism, which this series has apparently undergone. The more important of the facts, which have come under my observation, are as follows: the quartz, and especially the quartzites, are eminently slaty in structure, the latter sometimes so finely laminated as to split up into pieces not thicker than stout paper, and showing often incipient flexibility (itacolumitic); moreover the laminæ are coated with a very thin veneer of talcose, or more probably, hydro-micaceous matter (in some cases apparently damourite, in others with an exquisitely silky lustre, suggestive of sericite). Abundant examples were seen of the quartzite shading imperceptibly into compact quartz on the one hand, and on the other into talcose or chloritic schist, or even into iron ore.

The talc, and still more frequently the chloritic matter, passes by insensible gradations into iron ore, as well as from one to another. G. B. H.

thicken at the middle and thin out towards the edges, having the same general dip as the bed, but they do not succeed one another in one plane, their edges overlapping so as to throw the upper edge of the lower disc behind the lower edge of the upper.

The following is an ideal section of the Lincoln county ore-beds:



LINCOLN COUNTY ORE BEDS.

An ideal vertical cross-section of the two parallel beds of ore, showing the occurrence of the ore in lenticular masses. (By Geo. B. Hanna.)

A, Sandstone or quartzite. B, Talcose schist ("slate"). C, "Front" ore bed of actinolitic, chloritic and somewhat talcose schist, containing Ore Bodies. D, Talcose and chloritic schist contain small quantities of ore, mostly in grains. E, "Back" ore bed, for most part similar to C. F, Talcose schist. G, Gneiss.

The above-mentioned layers shade into one another; thus the sandstone or quartzite, A, passes into the silicious talcose schist, B, which in turn graduates into the "front vein," C—a mass of actinolitic, chloritic (somewhat talcose) slate, with iron ore in grains, or in lenticles. The change from the slates into the ore lenticles is frequently obscure, and the lenticles themselves are often schistose in structure. The change into the talcose slate (D) is equally obscure. In this body the ore is in grains, associated commonly with the chloritic matter, or in small lenticles.

The statements about C apply for the most part to the "back vein" E.

The changes into and from F are as in B, but the mass seems to be less silicious.

The separation of the ore bodies is sometimes very slight, and often they are connected by an almost imperceptible thread of ore, which needs the quick eye of the skillful miner to follow.

These lenticles are sometimes many feet thick, and frequently of great length and depth.

Big Ore Bank.—The most considerable of the Lincoln beds, and the one which has been the longest and most extensively worked, is known as the Big Ore Bank. This is situated some 7 miles north of the Carolina Central Railroad. There are several beds evident, but the scattered and partly filled openings do not allow of a satisfactory notion of their exact relations. The quantity of ore in the 2 parallel beds seems to be very great, rising at points to 18 feet, but as a rule it ranges from 4 to 12 feet in thickness.

The surface of the hill is still covered with a coarse iron ore gravel. Several crops of this gravel, including all the larger fragments of ore, have been removed; but others have appeared on the surface through the process of weathering and denudation.

Several furnaces and forges have been supplied with ore from this point for a long period.

Following the strike of the beds, about N. 20° E., a succession of ore beds (at least 14) are encountered at intervals from Big Ore Bank to the southeastern base of Anderson's Mountain. The more important are, commencing the enumeration on the south: Big Ore Bank, Brevard, Stonewall, Robinson, Morrison, Beard, Tillman, Deep Hollow, and Abernathy (in Catawba county), the latter being not far distant from the Shuford Gold vein, and quite near the Catawba River. Beyond the Catawba the beds are believed to become gradually thin and quartzitic.*

As additional deposits in Lincoln county: A vein of limonite crosses the public road about 7 miles northwest of Lincolnton; another is found of the same character about 5 miles southeast, and 1 mile east of Shuford's lime quarry. About 5 miles south of Cottage Home there is a good deposit of iron ore—a brittle magnetite passing into limonite.

The quality of the iron manufactured from these ores has always been good.

This lenticular occurrence is very common in North Carolina—in fact almost general in every kind of mining, though not always so abruptly marked as this illustration would indicate. Prof. Emmons (Geology of Midland Counties of North Carolina, 1856, p. 157), also alludes to this characteristic. and the same has been illustrated by writers on the Ducktown and neighboring deposits, particularly, and recently by A. L. Wendt, E. M., (School of Mines Quarterly, January, 1886).—G. B. H.

* To the southwest of the Big Ore Bank, iron ore is found on this belt near the C. C. R. R., about 2 miles west of Iron Station, having been cut in several pits of exploration, but the quality and quantity are not known.—G. B. H.

Limestone for fluxing is found convenient in the range of beds, which accompanies these slates 1 to 2 miles to the west.

The fuel used has always been charcoal, which can be procured at a low price, as the country is very well wooded.

Magnetite near Shelby.—In the neighborhood of Shelby, Cleveland county, a considerable deposit of dark magnetite appears. The ore is in the syenitic series, and seems to be abundant.

The lower part of the great iron range is found in the southern portion of Gaston county.

The ore beds, which have been worked, are all found south of the South Fork of the Catawba, and of its principal tributary, Long Creek.

The rocks here are the same body of schist ("slates"), talcose, argillaceous, quartzitic, which carry the ore of Lincoln. The ore beds appear to constitute a double parallel range, the divisions much more separated than in Lincoln, in the same range already described as granular, schistose; but there is a larger admixture of hematite.*

Costner Ore Bank.—This is the most northeast in the series. It is just south of Long Creek, and about one-fourth mile west of the Atlanta and Charlotte Air-Line Railroad. Its strike is N. 10° to 15° E., and its dip nearly vertical, but on the whole is believed to be slightly easterly. It has been worked to a depth of 106 feet. The vein is 12 feet wide near the shaft, and averages about 10 feet. The ore is a dense

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* This general statement needs some explanation. Commencing with the north, the prominent beds are: The *Costner*, 1 mile southwest the *Ellison*, 1½ miles still further southwest the *Ferguson*, the *Fulenwider* 1½ miles beyond the Furguson, and the *Yellow Ridge* still further to the southwest, being just under the west side of King's Mountain and about 1½ miles southeast of the railroad station of that name. One mile nearly north of west from the Ferguson is the *Mountain Ore Bank*, and still further 1½ miles in the same direction is the *Ormond*. The first five named are apparently in the same horizon as the Lincoln beds, and have similar ore, with some exceptions; the Yellow Ridge and the Ellison are certainly so, being on the east of the quartzite. The ores of the Mountain Bank are quite different, and those of the Ormond still more dissimilar.

The magnetic ores are more generally found in the eastern range, while the more western bodies are limonitic.—G. B. H.

metallic magnetite, free from injurious impurities. The following is Prof. F. A. Genth's analysis:

MAGNETITE FROM THE COSTNER ORE BANK.	(52)
Silica	4.34
Alumina	.44
Lime	.35
Magnesia	2.23
Oxide manganese	.28
Magnetic oxide of iron	92.18
Water	0.18
	100.00
Metallic iron	66.75
Phosphorus and sulphur	none.

Ellison Ore Bank.—The next deposit, one mile southwest, is the Ellison, with a strike N. to about 20° E., and a nearly vertical dip.

This bank carries a great deal of actinolitic slate. It has been worked to a depth of 90 feet. The ores are granular magnetites, more or less intermixed with hematite of great purity and richness; the analysis of Genth is:

ORE FROM ELLISON ORE BANK.	(53)
Silica and actinolite	23.80
Alumina	.96
Magnesia	1.30
Sesquioxide of iron	4.30
Magnetic oxide of iron	69.64
	100.
Metallic iron	52.61
Sulphur and phosphorus	none.

Ferguson Ore Bank.—The third in this series is the Ferguson, $1\frac{1}{2}$ miles still further on. This vein in its course, dip and width, is like the Ellison, but its ores are somewhat different; they have become more peroxidized, and are somewhat intermixed with iron pyrite; the contents of the ore will average 60 per cent. of iron, but the presence of the iron pyrite greatly diminishes its value for high grades of iron.

The Fulenwider Bed.—This bed is $1\frac{1}{2}$ miles S. W. It supplied much of the ore for the forge on Crowder's Creek near by. The ore is the

characteristic "gray ore," granular iron ore in a talcose or quartzose gangue. It is unfortunate that no records have been preserved, or are accessible, of the underground works of this mine, and of the size and character of the ore body, though the amount of work seems to indicate a body of some magnitude. It is in an eminently good mineral locality, and in its northeast extension, the surface of the ground is covered with the weathered out ore of some as yet undiscovered vein.

Yellow Ridge Ore Bank.—This ore bank lies two miles southwest of the Fulenwider. The ore is pre-eminently a gray ore, and is notably magnetic, but more peroxidized than is that class of gray ores generally.

This bed was extensively worked to a depth of 120 feet; the dip is westerly, but diverging only a little from the vertical. The last ore mined contained a considerable amount of iron pyrite, but as this occurred in layers, and not uniformly disseminated, it was readily sorted out. The vein has a width variously reported from twelve feet upwards.

The following analysis by Mr. Hanna will show the character of the working ores:

ORE FROM YELLOW RIDGE BANK.	(54)
Water (110°C.)	0.300
Further loss on ignition	3.830
Silica	8.390
Carbonic acid (anhydride)	trace
Sulphuric acid (anhydride)	trace
Phosphoric acid (anhydride)	trace.
Bisulphuret of iron	0.062
Protoxide of iron	24.790
Sesquioxide of iron	60.620
Alumina	.054
Oxide of manganese	.800
Lime	1.378
Magnesia	trace
Titanic acid	trace
	100.224
Metallic iron	61.743
Phosphorus	trace.
Sulphur	.033

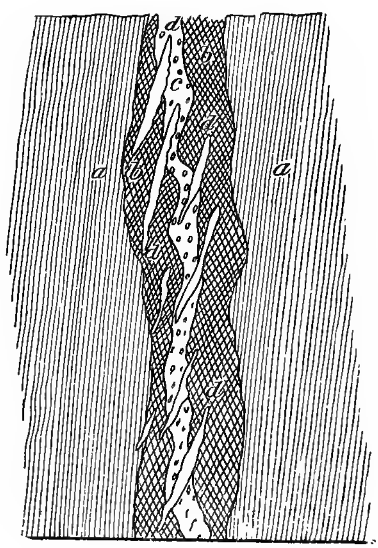
The late C. W. Garrett, who had worked the ore extensively in the forge at Crowder's Creek, regarded it as a fair working ore.

The other two important beds mentioned on page 160, are on the "High Shoals" tract.*

The first of them is the Mountain Ore Bank, one mile north of west from the Ferguson; the second, the Ormond Ore Bank, is $1\frac{1}{2}$ miles further in the same direction.

Mountain Ore Bank.—This is situated in close proximity to Whetstone Mountain, and is one-half mile east of the Atlanta and Charlotte Air-Line Railroad. Its course is N. 20° to 30° E.; its dip nearly vertical, but slightly to the westward 1° to 5°

The following section, reproduced from F. Winter, E. M., shows very well the relationship of the parts of the vein:



MOUNTAIN ORE BANK VEIN.

Vertical cross section, (by F. Winter). *a*. Talcose schist ("slate"). *b*. Limonite. *c*, Manganesic limonite. *d*, small seams of pure quartz.

It is a regular vein of limonite, fibrous, mammillary and cellular, a part of it earthy with a disposition to break out in angular fragments, evidently manganiferous and derived from chalybite. The

* This magnificent tract of 14,325 acres presenting an unparalleled combination of iron, gold, and pyrite veins, a large water power, and fine farming lands, all in proximity to three railroads, no longer exists in its entirety, as some of the farming and much of the mineral lands have been sold.—G. B. H.

vein is 4 to 8 feet wide, coursing N. 20° to 35° E., and does not vary more than 1° to 5° westward from the vertical.

The subjoined analysis, by Genth, shows the character of the ore:

FIBROUS LIMONITE (55) AND MANGANESE LIMONITE (56), MOUNTAIN ORE BANK.

	(55)	(56)
Silica	4.47	1.42
Alumina	trace.	trace.
Sesquioxide of iron	82.14	86.66
Sesquioxide of maganese	.53	5.12
Lime	----	.25
Magnesia	----	.27
Water	12.86	6.28
	100.00	100.00
Metallic iron	57.50	60.66
Sulphur and phosphorus	none.	none.

Ormond Ore Bank.—The most interesting bed of the entire series is undoubtedly the Ormond, and it has been the most extensively worked.

This vein has been opened for a distance of more than 500 feet, by pits and shafts. The No. 1 shaft has been sunk to a depth of 146 feet.

The walls of this vein are not always parallel, nor is the dip of each wall uniform; the average dip is believed to be west slightly; the course is N. 25° E.

The thickness of the vein is estimated at from 8 to 16 feet, and the best known part of the vein will rise to the highest of these figures.*

The mineral matter is made up of two classes of ore—a solid ore, and a loose, pulverulent, black material, locally called "Powder Ore," from its fineness and color. Even the solid ore is much jointed, and the interstices are filled with the powder ore; much of that which appears solid crumbles on exposure. This disintegration is generally attributed to the presence of manganese. The ore is partially hydrated and limonitic, or rather turgitic, and the powder ore sometimes occupies nearly one-half the vein.

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*I have seen one body 25 to 30 feet thick, and neither wall reached.—G. B. H.

Genth's analysis of the ore is given below:

ORE FROM ORMOND ORE BANK.	(57)
Silica and actinolite	0.84
Alumina	...
Sesquioxide of iron	88.56
Sesquioxide of manganese	5.17
Lime	.37
Magnesia	.30
Water	4.76
	100.00
Metallic iron	61.99
Sulphur and phosphorus	none.

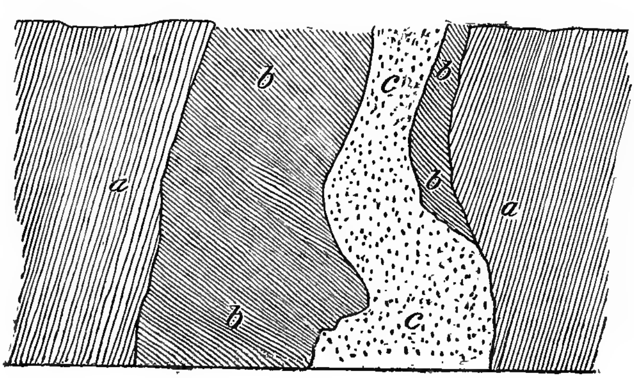
The analyses by Otto Wuth, of Pittsburg, are given below. The "powder ores" (58) and (59), are averages of four samples. Analysis No. 60 is of the "black ore:

"POWDER ORE" (58) (59) AND BLACK ORE (60) FROM ORMOND ORE BANK.

	(58)		(59)	(60)
Silica	0.43	to	4.27	0.78
Alumina	.78	"	2.57	1.41
Sesquioxide of iron	93.82	"	97.19	97.19
Lime	.45	"	.56	.49
Magnesia	.18	"	.24	.11
Phosphoric acid (anhydride)	.028	"	.076	.053
Metallic iron	65.67	"	68.03	67.97
Phosphorus	.013	"	.036	.023

Sulphur not more than trace.

The following section is redrawn from F. Winter, E. M.:



ORMOND ORE BANK.

A vertical cross section. (By F. Winter). *a*, Talcose schist ("slate"). *b*, Limonite. *c*, Powder ore.

Crowder's Mountain Ore Beds.—There is a succession of pa rallel beds of iron ore, on the summit, and west, and northwest flanks of Crowder's Mountain, which have a general strike of northeast and southwest; they dip with the formation, which is here prevailingly westwards, though not far from the vertical. This series is about 2 miles further east than that comprising the Ellison and the Yellow Ridge.*

Several analyses have been made by Mr. Hanna, which show ores of great purity, and frequently of great richness. These analyses are as follows:

ORES FROM CROWDER'S MOUNTAIN BEDS.

	(61)	(62)	(63)	(64)	(65)	(66)
Silica (and trace of titanic acid)	11.02	23.14	9.27	2.58	28.20	44.26
Sesquioxide of iron	72.	58.36	75.17	84.53	46.39	40.19
Protoxide of iron	2.03	5.40	2.68	1.30	1.07	1.13
Sulphide of iron	.09	.12	.20	.02	.25	.14
Sulphuric acid (anhydride)	.02	.12	.01	.01	.17	.10
Phosphoric acid (anhydride)	.05	trace.	.02	.07	none.	.15
Metallic iron	52.02	45.13	54.80	59.29	33.48	29.08
Sulphur	.056	.112	.111	.015	.20	.112
Phosphorus	.021	trace.	.009	.030	none.	.067

No. 63 was very red, laminated and gritty, and might better be classed as a ferruginous sandstone or quartzite.

There are other beds of iron ore on the east side of Crowder's Mountain, one of which, about a mile distant, a friend reports tracing by its outcrops for two miles; but no openings have been made there.

*The formation of Crowder's Mountain is eminently quartzose, and comprises strata of quartzite, gneiss and schists. Among the latter, and especially marked, is the abundance of much weathered cyanitic schist, which might easily pass for a conglomerate. The iron ore is frequently seen in boulders, one of which was judged to weigh 200 tons. Most of the ore seemed to be in layers of quartzite or schist, and often there is a transition from quartzite to ore, and *vice versa;* the extreme terms being a quartzose iron ore on the one hand, and a ferruginous sandstone or quartzite on the other. Some of the ore beds were charged with pyroxene, while others showed the mammillary, botryoidal or cellular structure, originally due to its deposition as bog ore.

The slope and summit of the mountain are so well clothed with vegetation, and so broken that the number of the beds, their width, distance apart, etc., could not be ascertained, much less their extent. No developments worthy of the name have ever been undertaken, which is much to be regretted, as the whole series is very promising.—G. B. H.

A vein of manganese ore exists near the west foot of Crowder's Mountain, which contains as follows:

MANGANESE ORE, FOOT OF CROWDER'S MOUNTAIN.	(67)
Silica	40.40
Oxide iron	12.15
Alumina	9.03
Phosphoric acid (anhydride)	.03
Sulphuric acid (anhydride)	.02
Sulphide iron	.22
Manganic oxide	29.78
Metallic manganese	21.45
Metallic iron	8.60
Sulphur	.112
Phosphorus	.013

There are five furnaces on this Lincoln and Gaston belt, and several Catalan forges. Most of the furnaces have been in blast for three generations—one for more than 100 years. They are of 3 to 7 tons capacity, and all use charcoal, and for the most part employ the hot blast, or more properly speaking, a warm blast. The iron produced has always enjoyed the highest reputation.

The belt of limestone adjacent furnishes a good flux, and the itacolumitic sandstone a very superior "firestone." Both timber for charcoal, and water-power are abundant.*

Powell Ore Bank.—This is located in Catawba county, 6 miles northeast of the Abernathy bank, and its ores resemble those of the latter. It is situated on the south side of Ball Creek, and on a hill 200 feet above the creek. The ore is magnetic, irregularly arranged, in a dark hornblendic gneiss, with decomposed, irregular, angular masses of feldspathic gneiss. The veins (or beds) of ore are numerous and quite irregular, with overlaps and jumps; the ore giving out at one place and suddenly reappearing at another. The main vein (or bed) opened to a depth of 30 feet by a shaft, is at that depth 3 to 4 feet thick, with a strike of N. 10° E. and a dip W. 60 to 80° and even 90°. A portion of this vein is covered up by a drift deposit.

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* For some years the conditions of the iron industry have not been favorable enough to allow there important furnaces to be operated, but the higher grades of ore have to some extent been shipped to Pittsburg and Birmingham to be used for mixing.—G. B. H.

On a parallel hill $\frac{1}{4}$ mile N. W. of the above is a similar ore bed.

Littlejohn Ore Bank.—This occurs 1 mile south southwest of the above, and is a part of the same series of beds. It is reported as affording evidence of the existence of large quantities of ore; and it is said to have been worked to a small extent. The ore is limonite and hematite, in a bed 4 to 5 feet thick. Strike N. 10° W.; dip 60° E.

This same ore also appears $\frac{1}{3}$ mile north of the Littlejohn Ore Bank, in an old cut.

Another bed of *limonite* occurs in Catawba county, a few miles northwest of Anderson's Mountain. The bed has a thickness of 5 or 6 feet. It furnishes ore for a small Catalan forge near by.

Forney Ore Bank.—In Catawba county, several miles northwest of the Powell ore bank and 7 miles southwest of Newton, there is a series of ore deposits known as the Forney Ore Bank, whose mineralogical and geological relations are entirely different from those of the ore beds of Lincoln. They occur in the syenitic belt (Lower Laurentian), which will be noted on the accompanying geological map, as lying in a narrow zone of 3 to 5 miles in width, (and parallel to the belt of Huronian schists), from the great bend of the Catawba River, nearly to SouthC arolina. The ore is a remarkably pure and heavy magnetite, and occurs in irregular massesscattered disorderly through the massive syenitic rock. The iron made from it was tough and strong.

Barringer Ore Bank.—This is located in Catawba county, 6 or 7 miles northeast of the Forney Ore Bank, and some 2 miles southeast from Newton.

Its ores and relations are like the last, but some of the ore is more granular, and is occasionally disseminated in grains in a light-colored granitic gangue.

The vein is nearly vertical, but the openings do not allow of an opportunity for measurements.

Limonite near Lincolnton.—In Lincoln county there is also another deposit which does not belong to any of the series above described. It lies about 2 miles east of Lincolnton on the plank road, and is traceable for several hundred yards by surface fragments. Theore is limon-

itic. No exposures have ever been made, but the quantity of ore must be considerable.

Iron Ores of Yadkin, Surry and Stokes.

The ores of this region occupy a relation to the Pilot and Sauratown Mountains similar to that of the Gaston and Lincoln ores to the King's Mountain range. They are found along the base and among the spurs and foot hills of the range. Like them, too, these deposits divide themselves into two groups geographically, one in Stokes and the other in Surry and Yadkin. They are all magnetic and granular, but differ in the two groups in their mode of occurrence.

In the group of ore beds of Surry and Yadkin counties, the ore is disseminated in grains, for the most part through mica schist and gneiss, and the earthy and rocky matter often bears a large proportion to the ore, and requires to be separated by stamping and washing before it is sufficiently concentrated for the forge. The rock is generally decomposed to a great depth, and the grains of ore are easily separated by very rude and cheap means. The beds have been long known, and have been used for supplying iron to this entire section.*

They were described by Dr. Mitchell, in 1842, as follows:†

"There is a series of beds extending in a northeasterly and southwesterly direction from the Virginia line to the Yadkin River. There are also some beds on the south side of the river."

Magnetic Ores on Tom's Creek.—In Surry county an example of this magnetiferous gneiss, and of the mode of occurrence, and the method of concentrating and reducing the ore is to be seen on Tom's Creek, a few miles northeast of the Pilot Mountain.††

The decomposed gneiss of the ore-bed has little appearance of an iron ore, and is, in fact, distinguishable mainly by its superior weight, the grains of magnetite merely replacing, in varying proportions, the mica and hornblende of the rock. Consequently the beds are not

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* I have been courteously supplied with much important memoranda of the iron ore beds of this section by John L. Worth, Esq., of Mount Airy. His profession as surveyor has enabled him to gather a large amount of information on this subject. He says that Worth's Forge, on Tom's Creek, was put in operation in 1787, and has been worked nearly continuously since.—G. B. H.

† Elements of Geology, &c., 1842, p. 139.

†† At Worth's Forge, and Dobson's Forge, as reported by J. L. Worth.—G. B. H.

defined at all, and the rock has been worked in any direction where it was found to pay.

Another ore bed and two forges (Hyatt's), are found on the west side of the Ararat River, near the mouth of Bull Run Creek. This ore bed is nearly west of the Pilot, in a light-colored schistose gneissoid sandstone.

A third ore bed, known as the *Williams Ore Bed*, which has been worked for many years, lies 4 miles northwest of Rockford. The rock is a hornblendic gneiss, and the mode of occurrence of the ore is very much as on Tom's Creek, but it is more disposed to gather into bunches and pockets and solid masses.*

Stanly Ore Bed.—Another locality in Surry county is on the farm of Edward Stanly, 10 miles from Elkin, on the Dobson road, and about 1½ miles north of Little Creek. The iron ore is found in the woods, scattered over several acres. From the pits sunk it would appear that the deposit must have a length of not less than 150 yards, but this could not be positively ascertained. There was no section near by to indicate the lithological relations of the ore, but some protruding rock and large surface specimens indicated the formation as largely of mica schist (the mica small and uniformly disseminated), with a little hornblende. The schists run apparently nearly N. 60° E., and dip southeasterly 75° to 80°.

The ore seems, so far as surface specimens were an indication, to be lenticular masses of limonite, sometimes changed into red hematite. The beds are credited with a width of 4 to 14 feet. The following are analyses of these ores made by Mr. Hanna:

IRON ORES, STANLY ORE BANK, SURRY COUNTY.	(68)	(69)
Silica	10.96	10.04
Metallic iron	52.62	54.52
Sulphur	.35	.41
Phosphorus	trace.	trace.

The iron made from the ores of Surry has a good reputation in that region.

Hobson Ore Beds.—In Yadkin county there is a series of ore beds

* Mr. John L. Worth calls attention to two other similar localities in the series not far southeast of Dobson.—G. B. H.

running from the Yadkin River in a southwest direction to Deep Creek. There are a number of mines here, the most noted of which are the Hobson mines. The ores are very much like those on Tom's Creek, but the beds are better defined, and the ore more concentrated in definite strata. The analyses below by Dr. Genth will show their character:

MAGNETIC ORES, YADKIN COUNTY.

	(70)	(71)	(72)	(73)	(74)	(75)	(76)	(77)
Magnetic oxide of iron	93.61	55.87	56.13	71.68	74.48	86.39	70.61	79.75
Oxide manganese	.11	.86	trace.	trace.	.04	trace.	.48	.81
Oxide copper	.10	.09	.05	.10	.04	.09	.15	.13
Alumina	.20	.45	1.88	2.46	.98	.75	.66	1.20
Lime	.45	3.14	.36	.57	.60	.70	1.34	.82
Magnesia	.86	1.94	.19	.10	.25	.77	.90	.98
Silica, actinolite, epidote, etc.,	4.62	37.24	40.60	24.62	23.16	10.83	24.28	14.46
Phosphoric acid (anhydride)	.05	.05	trace.	trace.	trace.	.09	.12	.10
Sulphur	....	.02	trace.	trace.	trace.	....	....	....
Water	....	.34	0.79	0.57	.45	.38	1.46	1.75
Metallic iron	67.79	40.46	40.65	51.83	53.93	62.55	51.13	57.75

The Hobson ores (several beds) are represented by Nos. 72, 73 and 76 of the above series; they have been used in the forges of the neighborhood for many years. The ore beds are in the northern part of the county, but others are found southward of them, and are represented by the other analyses. They are: the Sand Bank (70), Black Bank (71), Hutchins (74), Upper Bank (75), and Shields (77).

East Bend Magnetic Ore.—At East Bend, Yadkin county, is an outcrop of magnetic ore, which is coarse granular, and more free of rocky matter than most of the other deposits, but it has not been operated.

This range of ore beds extends southward across the South Fork of Yadkin River into Davie county, where the ore still preserves the same characteristics as in the above-mentioned counties, but of the extent of the beds and of their distribution, I have no definite information.

The northern or Stokes county group of the range lies on the east (north) side of the Dan River, and within 2 and 3 miles of Danbury. They are collected for the most part in a group of parallel beds, in a dark to black and greenish-black micaceous and hornblendic gneiss. The beds being very well defined, and the ore concentrated in certain definite strata, as in the case of the Rogers Ore Bank.

Rogers Ore Bank.—This deposit of ore is located in Stokes county, 2½ miles north of Danbury. Here the ore is pure in quality, coarse granular in texture, and is aggregated into masses of considerable extent. The bed is 8 feet thick, in mica, chlorite and hornblende schist; and has a dip of 20° E. It has been worked on a considerable scale; and an excellent iron was smelted in the furnace at Danbury during the late war. Another bed reported to be 10 feet thick was opened about half a mile east of the last; and two beds (one of them 4 feet thick, the other not opened) have been discovered at different times within 300 and 600 yards of it, on the west. The ores from these are all magnetic, with sometimes a small admixture of hematite. The following analyses are by Dr. Genth:

MAGNETIC ORES, FROM ROGERS ORE BANK.

	(78)	(79)	(80	(81)
Oxides of iron	92.47	85.09	79.71	67.66
Oxide of manganese	trace.	trace.	trace.	trace.
Alumina	trace	.70	2.27	.17
Magnesia	.20	.16	.17	.23
Lime	.13	.29	.31	.19
Phosphoric acid (anhydride)	none.	none.	none.	none.
Actinolite	7.20	13.76	15.66	31.75
Water	....	....	1.88	....
Metallic iron	65.34	61.74	57.13	49.03

The purity of these ores is conspicuous. Phosphorus is wholly wanting. Some samples contain a small percentage of pyrites. Manganese appears as only a *trace* in the analyses, but it must exist in larger proportions in some parts of the bed, as speigeleisen is occasionally an accidental product.

The above specimens of ore are all from the Rogers Ore Bank. There is also a small outcrop of limonite in the vicinity of the Rogers bed, of which Dr. Genth's anyalysis gives:

LIMONITE, NEAR ROGERS ORE BANK.	(82)	
Peroxide of iron	31.36	per cent.
Phosphoric acid (anhydride)	.44	"

The following is an analysis of a good magnetic ore from the Danbury Furnace property, adjoining the town of Danbury on the north,

made for the owner, Col. J. M. Heck, at the State Agricultural Experiment Station Laboratory:

MAGNETIC ORE FROM DANBURY FURNACE PROPERTY.	(82 a)
Silica and insoluble matter, mostly actinolite	11.690
Magnetic oxide of iron	87.990
Manganese	trace.
Phosphorus	.003
Sulphur	.005
Residue (composed of about 0.17 per cent. of magnesia and 0.16 per cent. of lime)	.330
Metallic iron	63.71

The Kiser Ore Bank occurs on the Danbury vein; and another deposit of magnetic ore is reported as occurring at Lee Nelson's, 3 to 4 miles northwest of the Rogers Ore Bank.

Magnetic Ore near Sauratown Mountain.—There are other outcrops of magnetic ore in this county, a notable one being on the south side of the Sauratown Mountains, among the head waters of the Town Fork of Dan River.

It is evident that here is an important iron range, which must become a centre of manufacture for the higher grades of charcoal iron, whenever transportation shall have been provided, either by railroad or by the opening of the navigation of the Dan, which is very feasible. The proximity of the Dan River coal beds is another advantage, which may prove of the highest importance.

Ore Deposits near Salem.—There are in the Museum several fine specimens of magnetic ore and micaceous hematite from Forsyth county, in the neighborhood of Salem, south and west of the town, which make it probable that there are valuable ore deposits in that section; but no definite information of the extent of the deposits is at hand.

Iron Ores of Burke, Caldwell, &c.

There are many valuable beds of limonite in a range extending in a northeast direction from the northeastern foot-hills of the South Mountains into the Brushy Mountains—from Jacob's Fork of Catawba River, near the eastern border of Burke, across the Catawba, and by way of Gunpowder Creek, to the waters of Middle Little River, near

the eastern border of Caldwell; and beyond, near Rocky Creek, in Alexander, and even on the northern slopes of the Brushy Mountains, in Wilkes, the same ores occur, being undistinguishable in appearance and of identical lithological relations. These ores are associated with the peculiar kyanitic hydro-mica schists, and purplish paragonite schists, which characterize this region.

There is a bed near the town of Hickory, reported to be 5 or 6 feet thick, and 3 miles west, at Propsts', are a number of pits from which ore was obtained during the war; 6 miles distant, on the lands of Mr. Townsend, a bed was opened some forty years ago, and a considerable amount of the ore smelted in the Shuford furnace near by. This ore was mixed with ore from the Barringer mine near Newton (already referred to), and the iron so made was reported to have been of good quality.

Limonite occurs on Chestnut Hill, near Icard's Station; magnetite is also found 6 miles from Morganton, towards Rutherfordton. On Ore Knob, 6 or 7 miles south of Morganton, there are several outcrops of chloritic red hematite; one mile further and near the end of the ridge, another hematite bed outcrops.

Iron was also made on Gunpowder Creek, Caldwell county, 40 or 50 years ago, from a similar series of limonite beds. The beds on Middle Little River, 12 miles southeast of Lenoir, were worked nearly 60 years ago. The outcrops are traceable on the slopes of McIntyre's Mountain, and Bald Mountain, near Mr. White's, on Miry Branch, for a distance of 2 to 3 miles; the outcrop on the former being about 3 or 4 feet, and on the latter 8 or 10 feet. There is every surface evidence of abundance of ore. Timber for fuel is abundant, and water-power also; and the proximity of the magnetites and hematites described below effects a very favorable combination of circumstances.

Fine specimens of magnetic ore are in the Museum, from near Morganton, and also from the vicinity of Hickory. On Steele's Creek, in the northwestern part of Burke county, there is an outcrop of magnite and hematite ore of the best quality. It is found on a spur of Brown Mountain, on Mr. Estes' land, (1875).

Limonite also occurs in Brindletown, among the spurs of the South Mountains.

A bed of superior magnetic ore is found on Warrior Creek not far from Patterson, Caldwell county, and within a mile of the bend of the Yadkin River. It is traceable hundreds of yards by large surface frag-

ments of a fine grained heavy metallic ore, remarkably free from rocky admixtures. A similar ore is also reported to be found in large quantity a few miles west on Mulberry Creek. A slaty hematite of great purity is found a few miles above on the spurs of the Blue Ridge, flanking the Yadkin River, in a cove known as Richlands. The faces of the slaty ore, as well as of the walling slates, are sprinkled quite thickly with small shining octahedral crystals of magnetite, many of which have been converted into hematite, constituting a fine example of *martite* schists.

The bed at this point outcrops only a few inches in thickness, among the thin-bedded and shaly argillaceous and micaceous schists of Linville, which show themselves in force along the flanks of the Blue Ridge in this section. Mr. Hanna's analysis of the ore is as follows:

HEMATITE FROM RICHLANDS COVE, CALDWELL COUNTY.	(83)
Sesquioxide of iron	96.14
Sulphide of iron	.08
Sulphuric acid (anhydride)	.01
Phosphoric acid (anhydride)	none.
Oxide manganese	trace.
Silica	2.25
Alumina	.87
Water	.85
Metallic iron	67.32

Titaniferous Iron Ore.—In the neighborhood of Richland's Cove, on the farm of Mr. J. Curtis (1875), on the banks of the Yadkin, 7 or 8 miles above Patterson, is a heavy ledge of titaniferous iron ore in a massive, granular, talco-chloritic gneiss of a light greenish-gray color.

The ledge is exposed in a cliff rising sheer out of the river, and again in the steep face of a hill 150 yards distant. The exposure is not less than 12 to 15 feet thick, and the surface is covered with heaps of angular fragments of all sizes, up to 100 pounds or more. The bed also in places contains a small proportion of chromium, according to Mr. Hanna.

Bull Ruffin Ore Bed.—Some 10 or 12 miles northeast of the above, on the flanks of the Blue Ridge, near Cook's Gap, in the edge of Watauga county, occurs another outcrop of the specular (martite) schist of Richlands. The bed at this locality, which is called Bull Ruffin, is reported to be 3 or 4 feet thick at the outcrop; and the neighboring

and enclosing rocks, granular quartzone schists and other characteristic schists and slates of the Linville belt, as well as the ore schist itself, are often impregnated with fine to coarse crystals of magnetite and martite. The ore strongly resembles the Richland ore. An analysis of this ore by Mr. Hanna is appended:

SPECULAR (MARTITE) SCHIST, BULL RUFFIN ORE BED.	(84)
Silica	2.617
Titanic oxide	trace.
Sulphide of iron	.048
Protoxide of iron	2.448
Sesquioxide of iron	92.916
Oxide manganese	.450
Phosphoric acid (anhydride)	very minute trace.
Metallic iron	67.671
Sulphur	.025
Phosphorus	trace.

There is also an outcrop of limonite near the same point, but no information of its extent has been collected.

The quality of this ore is so high as to justify an exploration of this promising outcrop, and indeed of the whole range, which does not stop at this point, but follows the line of the Blue Ridge for a distance of 75 miles, showing itself in the magnetiferous and martitic schists of Fisher's Peak on the Surry-Alleghany border, near the Virginia line.

Limonites of the Linville Mountains.—In McDowell county there are several beds of limonite. These are mostly aggregated along the top of Linville Mountain, southern part, and western slope near the foot, and in the spurs of the southern end. One of these ore-beds was worked by Mr. Conolly some 35 or 40 years ago. Another, Fleming's ore-bed, 2 or 3 miles south of Linville, on the slope of Graveyard Mountain, was opened also; and its thickness appeared to be 2 to 3 feet.

A limonite deposit outcrops in the county road, 1 mile N. 20° W. of the Pinnacle, Linville Mountains, for a distance of 100 yards, with a strike of N. 50° E. No developments had been made in 1877, when this region was visited.

The same ore deposit is said to appear south of Paddy's Creek.

Iron ores (limonite with göthite) also appear in the gap on top of the Linville Mountains near the south end, ½ mile from road to North Cove.

Other bodies of ore are reported over the ridge in a west course, about 1 mile distant from the last; and others are found in a southeast course in the forks of Paddy's Creek.

Beds of ore are reported to exist on a knob ¼ mile S. E. of Shortoff Mountain, north of the road and ½ mile above the "flexible sandstone" quarry, and extending on to Carson's Ore Bank of North Fork.

There is an ore bank in Peter's Cove, 1 mile to the east of the road, and 1½ miles from Yancey's iron mine. The rock is a shaly sandstone and itacolumite, with a strike of N. 10° W. and a dip 18° E.

These Linville limonites mixed with the magnetites and hematites of the region would become available for the manufacture of good metal. Ores of the last two species occur in the Linville River region.

The limestone beds of the same belt, in the North Cove and along the flanks of Linville, afford a good flux, and the forests of these mountains will furnish indefinite quantities of fuel.

The Yancey Mine.—This is situated 1½ miles N. 80° E. of Wood's Knob. The ore is magnetite, in quartzitic gneiss, with a dip west about 80°, the magnetite being distributed in lines and thin seams.

Magnetite also occurs in the Linville River region, and at Sampson's Mountain, in Yancey county.

Limonite at Ore Mountain.—Ore Mountain, 1 mile west of Swannanoa Gap, and just over the Buncombe line, is named from the occurrence on its flanks of a bed of limonite, which doubtless belongs to the iron ore range of Linville. The bed is not well exposed, but is visibly not less than 3 or 4 feet thick.

IRON ORES OF MITCHELL AND ASHE.

Cranberry Ore Bank.—In Mitchell county is found one of the most remarkable iron-ore deposits in North America.

It lies on the western slope of the Iron Mountain, (a part of the great Smoky range), in the northeast corner of the county, 3 miles from the Tennessee line, and about a mile from the rapid torrent of Elk River, the principal affluent of the Watauga. It has long been known as the Cranberry Ore Bank, from Cranberry Creek, which flows at the foot of the steep spurs, on which it outcrops. The prevalent and characteristic rock of the mountains in this locality is hornblende schist and syenite, and it is on the northern margin of a mountainous ledge of such

rocks that the ore bed occurs; gray gneisses and gneissoid schists coming in beyond in immediate succession and association, in part.

The ore is a pure magnetite, massive and generally coarse granular, and exhibits strong polarity. It is associated with pyrogene and epidote, in certain parts of the bed, as shown in plate X accompanying.

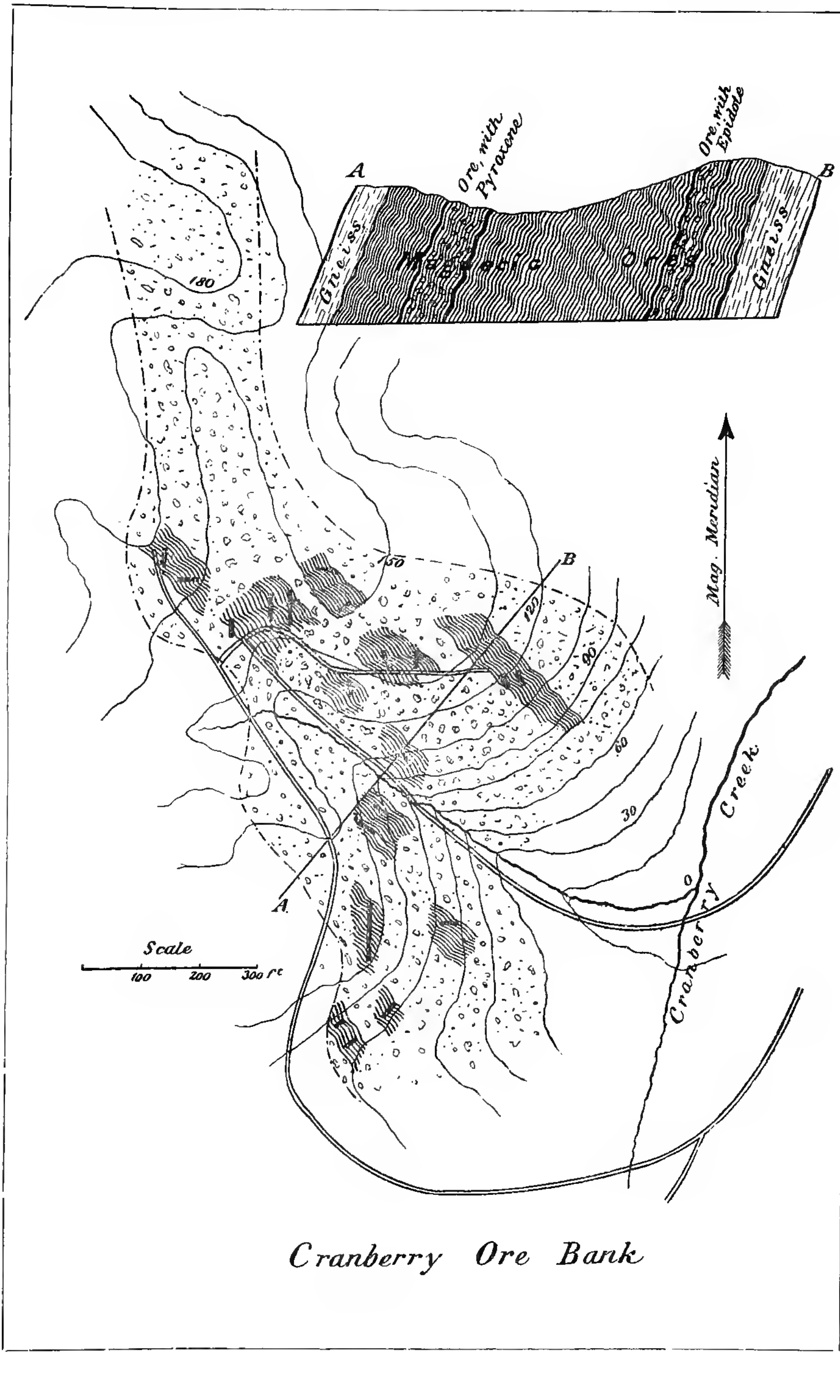
At the time the ore bed was examined, the steep slopes of the mountain, which the bed occupies, were covered with large blocks of ore, and bare vertical walls of massive ore, 10 and 15 feet thick, were exposed. The trenches and open diggings, which were scattered without order over many acres, everywhere reached the solid ore within a few feet of the surface. The length of this outcrop is about 1,500 feet, and the breadth 200 to 800,—600 in the section given in the diagram (plate X).

A large quantity of ore has been quarried and smelted for several generations, but until recently, no *true mining* had been done; for the loose, disintegrated masses of ore and iron gravel have been preferred by the ore-diggers, as being more easily obtained, and more readily treated.

The quality of the ore will best be seen by reference to the following analyses:

MAGNETITE, CRANBERRY ORE BANK.	(85)	(86)	(87)	(88)	(89)
Magnetic oxide of iron	94.37	91.45	85.59	80.77	91.89
Oxide manganese	.26	.06	.24	1.42	.32
Alumina	.42	.77	.11	.52	1.03
Lime	.43	1.01	.72	....	1.06
Magnesia	.36	.53	.33	....	.23
Water	....	.44	1.53	8.21	1.15
Silica pyroxene	4.16	5.74	11.48	9.08	4.02
Sulphur	....	....	....	....	0.25
Phosphoric acid (anhydride)	...	....	....	....	trace.
	100.00	100.00	100.00	100.00	99.95
Metallic iron	68.34	66.22	61.98	58.49	66.53

The first four of these analyses (85—88) are by Genth, who says "the first three samples contain neither titanic acid, no phosphorus and sulphur, the fourth contains a trace of phosphoric acid." The last (89) was made by Prof. Chandler, Columbia College School of Mines, New York City, who remarks: "This is the best iron ore I have ever analyzed; it is very rich in iron and very free from sulphur and phosphorus." The smiths and farmers of the region will pay fifty per cent.



Cranberry Ore Bank

more for it than for any other iron in the market. The softness and toughness of this iron is very remarkable, and its tensile strength, as tested by the United States Ordnance Department, ranks with that of the best irons known. The bed much exceeds in quantity the great deposits of Missouri and Michigan, and at least equals anything in the Champlain region. It is now controlled, and is being mined, by a Pennsylvania company, and is connected by a branch railroad with the East Tennessee and Virginia Railroad.

The topographical sketch of this ore-bed (see plate X) was taken rapidly and roughly, with a mountain level and pocket barometer, and gives the main features and measurements with approximate exactness. The epidote is not entirely confined to a single stratum, or part of the bed, being mixed to some extent with the pyroxenic gangue, which most abounds towards the west side of the vein.

The developments at this mine at the close of 1886, are briefly given below from notes of the general superintendent, C. H. Nimson :

The deposit is penetrated by one tunnel for over 500 feet, and by another tunnel at right angles to the first (at a level 50 feet higher) for 700 feet; 50 feet still higher are open works. The floor of this working is ore, and receives the ore from a breast or stope 50 feet high, and 500 feet long. Above this, and immediately over it, are two more stopes or breasts, each 50 feet high, and 200 feet long. These three open cuts are all in ore; and above this third bench is 130 feet of ore to be stoped or turraced out. All these workings, in connection with the diamond drill work, places a deposit of ore in sight 1,700 feet long, 400 feet wide, and over 300 feet deep, down to a level 50 feet above the level of the valley. Below this point no tests have been made, but the floor of the lowest tunnel has the richest and most solid ore that the mine has yet furnished. The present capacity of output is 100,000 tons per annum. The ore is used in Virginia, Kentucky, Tennessee and Alabama, and the demand exceeds the supply.

Other magnetic ore beds of less extent occur in this neighborhood. One is said to occur along the face of the same (Iron) mountain, between one and two miles eastward; and several others at the distance of six to ten miles in a southeast direction.

Northwestward, also, beyond the State line and within a few miles of it is a number of ore beds, mostly magnetic, with one limonitic. Indeed, it is evident that there is an extensive range of iron ores in this

region, which are of the highest quality, and must one day attract a large capital for their development.

Deposits of ore are also found in other parts of the county. One of these is a bed of magnetite, on the lower slope of Little Yellow Mountain, at Flat Rock; the ore of which is quite like that at Cranberry.

Specimens of menaccanite also are often found at this place.

On Rock Creek, beyond Bakersville, at the foot of the great Roan Mountain, are also several beds of magnetic ore, of which hand specimens resemble the Cranberry ore, and the geological associations are the same. Of the size of the beds no definite information has been collected, except in regard to one near the mouth of Big Rock Creek, where a little trenching has been done, and a few small veins or beds of one or two feet thickness were cut. The rock is gneiss, syenite and doleryte, much decomposed superficially.

Extensive ore deposits are found about the head waters of Big Rock Creek, northwest of Roan Mountain, on top of ridge in the vicinity of Little Rock Mountain. The ore is a solid compact magnetite, capped with a slaty mass, which is a magnetiferous and quartzitic conglomerate. In the rock between the ore beds much epidote is found.

Three miles from Bakersville, on lands of Avery Parker, on Pumpkin Patch Mountain, near the gap, specimens of fine heavy magnetite have been found in the woods $\frac{1}{4}$ mile from the house; it is found on the suface in blocks.

Limonite Ores.—In Mitchell county there are several beds of limonite deposits that are worthy of mention.

One mile southeast from Bakersville, in the woods near the road, an extensive ledge of limonite outcrops, with a strike of N. 75° E. The ore in sight is of rather poor quality. The country rock, as it appears in the road and creek, is a gray micaceous gneiss with a strike N. 60° E., and a dip E. 30° to 40°.

Another large outcrop has been reported as occurring $\frac{3}{4}$ mile east of the above, on lands belonging to Reuben McKinney.

Another bed of limonite occurs four miles northwest of Flat Rock, recognizable by the abundance of surface fragments, but no explorations have been made.

Magnetic Ores of Ashe County.—In Ashe county, in the northwest corner of the State, there are some important ore deposits, on the waters of the North Fork of New River. They lie chiefly north and north-

east of Jefferson, on Horse Creek and Helton Creek. On Horse Creek are two beds of ore, both coarse magnetite, highly polaric, in gneiss and syenite, the gangue being largely pyroxene and epidote. One is on a high mountain ridge, some 500 feet above the creek, on its west side. and two miles from Hamptons; the other on the east side at Graybills, on a hill 200 feet or more in height. The numerous surface fragments indicate beds of considerable extent.

On Helton, 6 or 8 miles east of the last, are still larger deposits, of very pure magnetic ore, which has long been used in the forges of the neighborhood. The ore is a coarse-grained and very pure magnetite, one of the beds of which is reported to be 18 feet in thickness, and another 9 feet. This is manifestly an iron region, and worthy of a thorough investigation.

Iron ore is found at W. B. Balton's, on North Fork of New River, 10 miles north of Jefferson. The deposit is large, and occupies an elevated site.

There are many other localities in this region, from which hand specimens have been brought to the Museum, as, for example, Cove Creek, in Watauga, which has furnished both magnetite and limonite, and the neighborhood of Flat Top Mountain, where a titaniferous ore is found.

Iron Ores of the French Broad.

There are several localities on the western slopes of the Black Mountain, on the head waters of Ivy Creek, in the eastern edge of Madison county, where *magnetite* is found on the surface.

A bed of *titaniferous iron* occurs here near the public road, and about midway between Asheville and Burnsville. The prevalent rock of the region is gneiss, with much hornblende schist and syenite.

There are many fragments of this ore of considerable size along the steep slope of a mountain spur. It is very hard, lustre resinous, color black, fracture sub-conchoidal.

The analysis of the ore by Mr. Hanna is below:

TITANIFEROUS ORE, MADISON COUNTY.	(90)
Titanic acid	37.88
Protoxide of iron	37.06
Sesquioxide of iron	11.03
Sesquioxide of manganese	.89
Alumina	9.51

Lime	2.57
Magnesia	.93
Sulphur	.09
Phosphoric acid (anhydride)	trace.
Water	.15
Silica	.83
	100.94

Smith Mine.—The H. B. Smith Mine is near Ivy Creek, 2½ miles from the junction between that creek and the French Broad River, and also 6 miles from Alexanders'.

The ore deposit occurs in a hill about 150 feet high, approximately ½ mile south of and sloping towards Ivy Creek. It outcrops in the woods on the top of this hill, on its northern slope, and on another hill across the ravine. The ore is a dark magnetite, and presents a fine appearance.

The country rock is a hornblendic gneiss and schist. The gangue is pyroxene and some epidote, as at Cranberry, and Horse Creek, in Ashe county. At the upper cut, 5 feet deep on the hill, the ore bed in decomposed hornblende and pyroxene rock, is 12 feet wide. At the second opening below, on the north slope of the hill, the deposit is about 20 feet thick, the bed widening out as the slope is descended.

A cross section of the ore bed about half way down the hill shows a thickness of twenty feet, with a westerly dip of about 60°. The ore is found more especially near the sides and in the center of the bed. The outcrop is along a nearly north and south line.

Magnetite in huge solid masses is found on Upper Spring Creek.

On Bear Creek, below Marshall, near the French Broad, there are surface fragments of magnetite in hornblende schist.

On the eastern fork of Big Laurel there is a large outcrop of a schistose granular magnetite at Mrs. Norton's, and near Jewel Hill occurs a bed or vein of specular hematite in a reddish felspathic gneiss where this ore is said to be abundant.

Specimens of iron ores have been sent to the museum from the following localities:

Redman Mine, on Bear Creek, below Marshall, on west side of French Broad River, about 1 mile distant. The ore is a magnetite of good quality.

Freeman Mine, near same locality—a magnetic ore of good quality.

Sikes Mine, near the Freeman. From this latter two kinds of ore

were forwarded: (1) a bright specular ore seamed with quartz; (2) a dull granular magnetic specular ore.

There are also in the museum specimens of magnetic ore brought from the eastern part of Buncombe county.

Magnetic ore is reported as occurring on Turkey Creek.

About five miles west of Asheville a bed of limonite of several feet thickness has been opened.

There is a range of limonite ore beds associated with the limestones of this county, which follow them from Cane Creek across and up the French Broad into Transylvania.

Three miles from Alexanders across the French Broad River, and 12 miles from Asheville, a bed of limonite is reported by E. M. Carter.

Limonite is further reported by Mr. Carter as occurring in a very wide bed 3 miles from the French Broad River, and 1 or 2 miles from the State line.

In the northeastern part of Haywood county, on Wilkins' Creek, is a bold and massive outcrop of granular magnetite.

There are also magnetites and hematites in various localities of Jackson and Macon, where extensive deposits are reported.*

Magnetite iron ore is found at Fish Hawk Mountain, in Macon county, and limonite at Quallatown, in Jackson county.

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*NOTE.—To Professor C. D. Smith is due the memoranda respecting the following localities, which, with some condensation, are as follows: "Magnetic ironexists in "many counties west of the Blue Ridge; lithologically considered, it is not confined to "one class of rock. I have gathered some facts which lead me to believe that val-"uable deposits of it exist at several points."

"The first range to be noted in order is the Spring Creek section."

"Three localities are noted on Fine's Creek, also at the head of Spring Creek. and "at Mr. Hardy Nolan's."

"The second zone passes through Madison a few miles south of Marshall, crossing "the French Broad a short distance above the mouth of the Ivy. About 3 miles up "the Ivy, magnetite occurs on the lands of Joseph Siler, where a vein of 2 to 3 feet "is found.

"The third zone in which magnetic iron occurs is in the copper and corundum "belt. In this zone the magnetite is found in syenite gneiss, and sometimes with "chlorite."

Among the localities are: "Elijah Creek in Macon county, about 8 miles south-"east of Franklin, on the lands of Messrs. Ward and Moses. Four miles southeast "of Franklin specular iron exists on the lands of Gen. T. M. Angel; large masses "are scattered over the surface. One mile from this place, at Wm. Washburn's, "magnetic iron is found. Near the base of the Nanteyahee Mountain, at the head "of Cartoogajay Creek, there is another locality of magnetic iron, on lands of W.

Iron Ores of Cherokee County*.

There is no other county in the State which contains so much iron ore as Cherokee. It is all however of one species, limonite. The marble beds of Valley River and Notteley River are everywhere accompanied by beds of this ore. There seem to be generally 2, 3 and 4 parallel beds of it, on or two of which are frequently schistose and micaceous,—a limonitic schist, and the others cellular concretionary &c., and (the most western, generally) ochreous. The breadth of this iron and marble range is 2 to more than 3 miles.

The trough which has been scooped out by the rivers, in a northeasterly and southwesterly direction, owes its existence to the destructible beds of limestone and their associated soft mica-schists and hydromica schists and shales, which occupy this tract. The direct valley range is about 24 miles in length; and there is bifurcation of it, at a point 6 or 8 miles above Murphy, one branch pursuing a more southerly course, by way of Peachtree Creek and Brasstown Creek, making the whole iron range of the county above 30 miles.

The most common and characteristic terms of the series, in cross section, are, counting from the northwest, schistose gneiss and mica schist, limonite, steatyte, marble, limonite, schistose quartzyte, schistose limonite, mica-schist and schistose gneiss.

At several points there are two or three reduplications of the marble, and there are commonly intercalations of mica schists and hydromica schists between the different terms of the series. The section at Valleytown shows two parallel beds of limonite on the slope of the mountains to the south, these beds being sometimes not more than 100 to 200 yards apart. The marble lies in the valley, and the schistose talc beds to the north side of the valley, and a bed of ochre north of that, outcropping in Paint Creek, 6 to 10 feet wide. There are here two or three parallel beds of marble. Lower down, at the Parker Mine (gold), and across by the Taylor place, are, first, the 2 beds of limonite, some 200 yards apart, then the valley, with its mar-

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"C. Kinsey. The quantity of ore distributed on the surface indicates a vein of fair "dimensions."

"There are many points along the whole Blue Ridge range, on the west slope, "where I have observed fragments of magnetic ore. There is a probability that "numerous veins of this valuable ore will be discovered at other points."—G. B. H.

*Reprinted with but slight alteration from Prof. Kerr's Geology of North Carolina, 1875, p. 268, *et seq.*—G. B. H.

ble and steatyte, with an outcrop of limonite to the north. This is nearly half-way between Valleytown and Murphy.

At Colbert's, the quartzite ridge appears with iron beds on both flanks. This is 6 to 7 miles above Murphy, where some rude mining has been done for iron ore quite recently, and much more and more systematic mining in ancient times, by no one knows whom or for what purpose. There are still visible shafts more than a hundred feet deep, which are said to have been approached by drifts, of which some signs of the entrance still remain. The marble here comes next the iron, to the northwest, and then the steatyte. The latter appears of unusually fine quality in a large bed near by, at Mrs. Leatherwood's.

At Mrs. Hayes', the quartzite appears with its northern bed of limonite, followed by the marble, talc and another bed of limonite. At several points between this and Murphy the same terms of the series are discoverable. About one mile north of Murphy the quartzite forms a high ridge, having the two beds of limonite, one on either flank, that on the northwest very fine and 25 feet thick. From this point much ore has been obtained for the supply of the neighborhood forges, chiefly the one on Hanging Dog Creek. The iron was reputed of very good quality. Beyond this bed of ore in the same section, is the marble and talc of "No. 6."

At one-half mile below Murphy there seem to be four limonite beds with a small outcrop of the quartzite, the marble occupying the middle term of the section. One of these beds may be seen in the streets of Murphy; but half a mile below, are two fine outcrops, indicating the presence of immense quantities of ore. Taking the course of the Noteley to the southwestward, the two limonite beds, with intervening quartzite, appear near the Ducktown road about 5 miles from Murphy, and there is a large outcrop also at the bridge six miles from Murphy. There is a large quarry of steatyte within the same distance.

Ascending the Hiwassee from Murphy, on the south bank, at the distance of about 2 miles, and after passing a heavy bed of slaty gneissoid quartzite, is a large bed of limonite; and beyond this, other quartzose gneisses, much-veined; then a second bed of the ore, after which come hydro-mica schists, and at 3 miles (Martin's), white marble. Half a mile beyond is a fine bed of limonite 10 to 12 feet thick, which has been worked to some extent, and a few hundred yards further is a bed of blue marble, which is reported to occur also on Brasstown Creek. The steatyte does not show itself in this section, being concealed by

superficial deposits, but in another section a little north (less than 2 miles), it comes in as a brown spongy decomposed massive talcose rock just west of Garrison's, the marble and iron ore appearing on both sides of it at Garrison's, and west of the ledge; this last being an ochreous bed, associated with quartzite. Eastward of Garrison's, on this section, at Williams', the marble appears, and at Southard's, both marble and limonite; and the marble and iron are reported as outcropping again at Coleman's, on Little Brasstown Creek, the marble here having a greater thickness than at any other point, many hundreds of feet. The last outcrop in this direction of the marble and limonite is near Peachtree Creek, between 7 and 8 miles from Murphy. So that here the beds must have suffered much and rapid folding or faulting.

These beds of ore are traceable northwards to within two miles of the Valley River beds near Mrs. Hayes'.

The quantity of ore in this county is therefore immense, and very widely distributed, and the forests of the mountain slopes furnish unlimited supplies of fuel, while the marble is at hand everywhere for fluxing. The quality of the ore may be inferred from the following analysis by Dr. T. M. Chatard for Genth of a large mass obtained from the open cut a mile north of Murphy:

LIMONITE, NEAR MURPHY, CHEROKEE COUNTY.	(91)
Sesquioxide of iron	85.69
Silica	1.50
Water	12.81
Metallic iron	59.98

The above description of the Cherokee ore beds is made from the abbreviated notes of a hurried exploration made several years ago. These fine ore ranges are eminently worthy of detailed study and mapping.

Spathic Ore.

The following notes concerning the occurrence of spathic ore (siderite) in the State may be added as a sort of appendix.*

This spathic ore is found in many of the mines of Cabarrus, Rowan, Davidson and Mecklenburg, sometimes in considerable quantities, but

* See also this volume, p. 80, for additional notes on this subject.

unfortunately it is commonly found associated with copper pyrite, and from the presence of sulphur in relatively large proportion, is unfit for iron making. A sample of this siderite from the Conrad Hill Mine in Davidson county, according to Dr. Genth, has the following composition:

SIDERITE, CONRAD HILL, DAVIDSON COUNTY.	(92)
Oxide of iron	47.70
Oxide of manganese	2.06
Magnesia	10.77
Lime	.63
Carbonic acid, water etc	38.84
Metallic iron	37.10

In conclusion it may be stated that this section on the iron ores of North Carolina is necessarily brief and imperfect, although information has been songht from every source.

Much yet remains to be done to complete the descriptions; there are many blanks to fill, and whole counties to be examined, of which little is known except the bare fact that they contain iron ores. The investigations have of necessity been limited, in the main, to the study of such ore beds as have happened to be open or accessible, which, as a matter of course, are but a small proportion of the whole, in a region where the industrial activity of the people is almost exclusively given to agriculture.

SECTION 2. SILVER, LEAD AND ZINC.

These three metals do not abound in North Carolina. As a rule they are associated.

Native silver was found in some quantity at Silver Hill, in Davidson county, and has also been observed at the McMakin and Trautman mines at Gold Hill, and at Copper Knob Mine, Ashe county. Sulphuret of silver is also reported to have been seen at the latter mine. Chlorides and bromides, with the associated minerals, are found only in extremely small quantities, and are of no importance commercially.

Silver is universally present with gold, and alloyed to such an extent as to form a noticeable item of profit to the producers of gold bullion, which contains the less valuable metal in proportions ranging from 25 to 500 one-thousandths in fineness.

Zinc ores dissociated from galena are very rare, while lead ores free from large amounts of zinc are also infrequent. In a word, the lead ores of North Carolina are unusually zinciferous; they are commonly argentiferous, and to a slight extent auriferous.

The resources of the State in these metals may be briefly described.

A remarkable belt (or belts) of galena and its associates extends along the western edge of the central "Huronian" area, from near the South Carolina line in Union county, to the southeast part of Davidson county, near the Randolph line—a distance of some 60 miles. The width of the belt will not much exceed 5 miles.

This narrow belt may divided into two narrower belts, each with its peculiarities. The more western, which joins the granite on its eastern edge, has galena with less blende, and perhaps more silver. Not infrequently, there is more gold by weight than silver; and this is especially true of the galenas of Union and Cabarrus counties.

The more easterly belt, which is not further east than about three miles,* has, so far as present discoveries show, larger masses of ore, but the ore is more refractory.

This classification is approximately correct, but the section needs further study before the details can be exactly stated.

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*Emmons' Geology of Midland Counties of North Carolina, 1856, p. 210, says: "The Gold Hill part of this belt is on the west of the conglomerate, and the Davidson extremity is upon the eastern side of it."

The Steele and the Henderson mines, in Montgomery county, near the Uwharrie River, are nearly fifteen miles further east, and do not fall into either class.

The description will commence with the more westerly belt adjacent to the granite.

Galena is found at the Davis, Phiffer and Lewis mines in Union county, some six miles south of Matthews, on the Carolina Central Railroad. It has not hitherto been shown to be of commercial value, but it exists in such quantities in the bedded veins as to give a large admixture of silver with the gold, for which these localities are operated; and not infrequently reduces the fineness of the gold to 500 or even 400.

It is also found in some of the numerous gold deposits of the Hemby Mine, just to the north of the Lewis, and with a similar lowering of the grade of bullion.

Smart Mine.—At this mine, in Union county, four miles nearly southeast of Matthews, and about one mile south of the C. C. R. R., galena occurs in relatively large quantities, but the resources of the mine are not known, for by reason of the want of a home market for galena, its presence in a gold mine, for which this mine was formerly worked, was regarded as undesirable, and led to the abandonment of work.

The ore body has been proved to the depth of 110 feet, and three levels at 35, 60 and 95 feet respectively, have been run, each of which is about 60 feet in length.* The vein is at times 3 to 4 feet thick; but the width of the ore seam is considerably less. The ore is galena with pyrite in a matrix of quartz. Assays of working lots are as follows:

ORES FROM SMART MINE, UNION COUNTY.	(1)†	(2)
Gold, per ton	6-10 oz.	2 ¼ oz.
Silver, per ton	3 1-20 "	4 6-10 "

(The coining rate of gold is $20.671 per ounce, and of silver $1.293 per ounce.)

It is claimed that the average value of the ore is for gold and silver about $30 per ton, nearly equally divided between the two.

Lemmonds Mine.—In Union county, two miles northeast of the Smart, is the Lemmonds (or Marion) Mine, which Prof. F. A. Genth describes

* J. C. Bates, Esq., of Monroe, has kindly furnished the account of the underground work, etc.—G. B. H.

† In this and subsequent assays, the forms 6-10 oz. etc., represent fractions of an ounce.

as follows:* The vein is "irregular in size, sometimes widening out from a few inches to six feet. It consists of quartz richly charged with brown zinc blende and galenite, with small quantities of arsenopyrite, chalcopyrite," etc.

A pure specimen of galenite, which did not show any *free* gold, (assay No. 3) and one of brown zinc blende (No. 4) were assayed by Genth, and yielded gold and silver per ton, as follows:

ASSAYS OF GALENITE (3) AND BLENDE (4), LEMMONDS MINE.

	(3)	(4)
Gold, per ton......	30 oz.	32 oz. of which nearly one-half was gold.
Silver, per ton	86½ "	

According to Prof. Genth: "This vein appears to have a considerable longitudinal extension, and passes into the Stewart Mine property."†

Stewart Mine.—At this mine, in Union county, have been found occasional bodies of ore containing galenite, similar to the ores of the Lemmonds; but the mine has attained its reputation through its auriferous ores. Assays of ores containing galenite are as follows:

ORES FROM THE STEWART MINE, UNION COUNTY.

	(5)	(6)	(7)	(8)	(9)
Gold, per ton	2 15-100 oz.	1 6-10 oz.	2 oz.	2 oz.	15-100 oz.
Silver, per ton ...	4 45-100 "	4 42-100 "	5 10-100 "	3 10-100 "	10 90-100 "

The lead was not determined, but enough was present to form a desirable constituent in smelting. This class of ore is easily hand-dressed to a richer material.

The Moore Mine.—This mine is located in Union county, one and one-half miles northeast of the Stewart; and its ores resemble those of the Smart.

ORES FROM THE MOORE MINE, UNION COUNTY.	(10)	(11)	(12)
Gold, per ton	6 oz.	4-10 oz.	1 oz.
Silver, per ton	90 38-100 "	1 18-100 "	1 8-10 "
Lead	33 per cent.	small.	small.

* Kerr's Geology of North Carolina, 1875, p. 290.

† NOTE.—It may be incidentally mentioned that there is also here a large gold vein, which has been very productive. There are several nearly parallel veins on this tract, of which this "Lead Shaft" vein is one.—G. B. H.

No record is known of the underground work, or extent or character of ore.

Galenite is also found at the Long (or Crowell) Mine in the same neighborhood, but the lead-bearing vein has never been worked.

This ore belt extends along the eastern border of Cabarrus county.

Rocky River Mine.—The Rocky River mine occurs near the river of that name, in Cabarrus county, ten miles nearly southeast from Concord. It has five veins, some of which carry galena in noticeable quantity, and it is also equally noticeable that, when the galenite is more abundant, there is a corresponding enrichment in the gold contents.*

Allen Furr Mine.—The Allen Furr (or "Silver Valley") Mine, eleven miles southeast of Concord, and in the same neighborhood as the Rocky River Mine, also carries a small proportion of galenite in a gangue of massive pyrite. The galenite is for the most part disseminated in small proportion, but occasionally is found free enough to constitute a true lead ore. But it is doubtful if any considerable amount proves to be as rich as is indicated by the following analysis:

ORES FROM THE ALLEN FURR MINE. CABARRUS COUNTY. (14)

Lead	34.18 per cent.
Zinc	small.
Gold, per ton	1 2-10 oz.
Silver, per ton	10 8-10 "

This mine will be noticed again in the section treating of gold mines.

At Gold Hill the belt again becomes prominent in the McMakin and Trautman mines.†

* A recent analysis of an average sample shows the following result as to the mineral constituents treated of in this section:

ORE FROM THE ROCKY RIVER MINE, CABARRUS COUNTY. (13)

Lead	2.64 per cent.
Copper	.15 "
Zinc	.94 "
Arsenic	trace.

As such mine matter is readily concentrated it will be seen that a product may be obtained (particularly as such ore contains a fair amount of gold and silver), which will be a valuable adjunct in the metallurgy of the precious metals, where the treatment by lead smelting is employed.

† For the general topographical characters of this district, see description and map of the Gold Hill district.—G. B. H.

McMakin Mine.—The McMakin (or Silver) vein is situated in the southwest part of this district, and in Cabarrus county. No work has been done on it for twenty-five years. It was entered by three shafts, the deepest of which was 181 feet; and two levels were driven, one at 66 feet, the other at the bottom.

The vein occurs in a talco-argillaceous schist,* the hanging wall being prevailingly talcose, and the foot wall prevailingly argillaceous. It is found parallel to the general line of stratification, viz.: N. 45° to 60° east, and with an easterly dip 70° to 75°.

There are two veins, designated as the Main vein and the Little vein. The outcrop consisted largely of brown hematite, psilomelane, pyrolusite, and dolomite—the first and second predominating. Manganese ores disappear at a depth of twenty feet; then plumbago, pyromorphite and cerussite come in; and these in turn go out at 60 feet, being replaced by galenite, blende, pyrite, chalcopyrite, and highly argentiferous tetrahedrite. The prevailing gangue is carbonate of lime and barite with quartz. Down to 70 feet yellow blende, assaying 14 to $39\frac{32}{100}$ oz., occurs in larger amounts than galenite; then the latter predominates, and is accompanied by an ever-increasing amount of tetrahedrite, and assaying 12 to $53\frac{15}{100}$ oz. silver.

The following statement by Mr. O. J. Heinrich, E. M.,† will show the characteristics fully: "At the depth of 76 feet between the south and "the whim shafts the vein is four to ten feet wide, the vein fissure being chiefly occupied by carbonate of lime and barite.

"This gangue carries grains and small masses of tetrahedrite to a "width of two feet at the southeast; the central part of the vein con- "tains several seams of tetrahedrite and yellow blende, and the north- "west has yellow blende with galenite and many grains of tetrahedrite. "Tetrahedrite is found at its best close to the hanging wall in the south- "east. Average samples according to Dr. Genth gave:

SILVER ORE, MCMAKIN MINE, CABARRUS COUNTY.	(15)	(16)
Silver, per ton	245 9-10 oz.	500 oz.

"Simple cobbing increases the contents as in No. 16.

"There is a small parallel vein west of the main vein, which has "been extensively stoped, from the whim shaft to the surface; its course

* This schist ("slate") has a decided chloritic tendency, and may often be called chlorite schist.—G. B. H.

† In a MSS. report to the owners of the property.

"is N. 50° to 60°; and dip southeast 35°. There are probably other "parallel veins both to the northwest and southeast, for the whole belt "is metaliferous."

Work was terminated at this mine, in 1861, and the vein has not since been touched.

Trautman Mine.—The Trautman Vein, in Cabarrus county, one mile southeast of Gold Hill, was originally opened as a gold mine. The ore near the surface consisted of very rich, auriferous, porous quartz. At the depth of 100 feet, where the sulphurets are unaltered, the ores were poorer, and contained a string of ash-gray blende, and pyrite from 2 to 6 inches wide, which had much increased at greater depths.

Silver Hill Mine.—Two large deposits of zinc bearing galenite exist in Davidson county,—Silver Hill, ten miles southeast from Lexington; and Silver Valley, five miles northeast from Silver Hill, and near the border of Randolph county. The two deposits at considerable depth carry similar ores, but the shallower deposits were quite dissimilar.

The country is an argillaceous schist ("slate"), very indurated, with a marked chloritic tendency. Hard silicious schists are also frequently seen*.

From the imperfect records of the mine now accessible it is believed to have been discovered in 1838. For a considerable time the gossan was worked as a gold mine; its outcrop was not prominent. The tract embraces a little more than 1,000 acres, and there are over 6,000 feet of vein formation.

This mine has been more extensively worked (the Gold Hill excepted) than any other in North Carolina; and from this fact, and from the extensive prospecting, which has been done, it allows and demands a careful description.

As usual, in all mines in this section, the ores rapidly changed at the water line, and became, with some alterations and exceptions, slightly argentiferous blende and galenite, and have on the whole proved very refractory. Plates Nos. XII and XIII show all the important under-

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* Emmons' Geology of the Midland Counties of North Carolina, 1856, p. 185. says: "The age of the vein fissures of this mine is of the same period as the auriferous veins of this formation. There is a parallelism and a general resemblance in the characteristics of all these repositories."

ground features. Down to the 200 foot level the drawings are from actual surveys by R. C. Taylor and Jas. V. Symonds; below that point they are made from notes and statements by the old superintendents and underground bosses, especially Mr. James Prim, and are to be regarded as only approximately correct. No records of a survey of this lower part of the mine exists.

Much the greater part of the ore has been taken out by the Engine shaft (at first known as the Whim shaft). Down to 200 feet this shaft was vertical; from the 190 foot level of this vertical shaft an inclined shaft was sunk to a nominal depth of 660 feet; this incline was in the back or east vein, and in the main followed the dip of the vein. Both veins were worked from these shafts, as shown in plate No. XII, in the vertical section through the engine shaft.

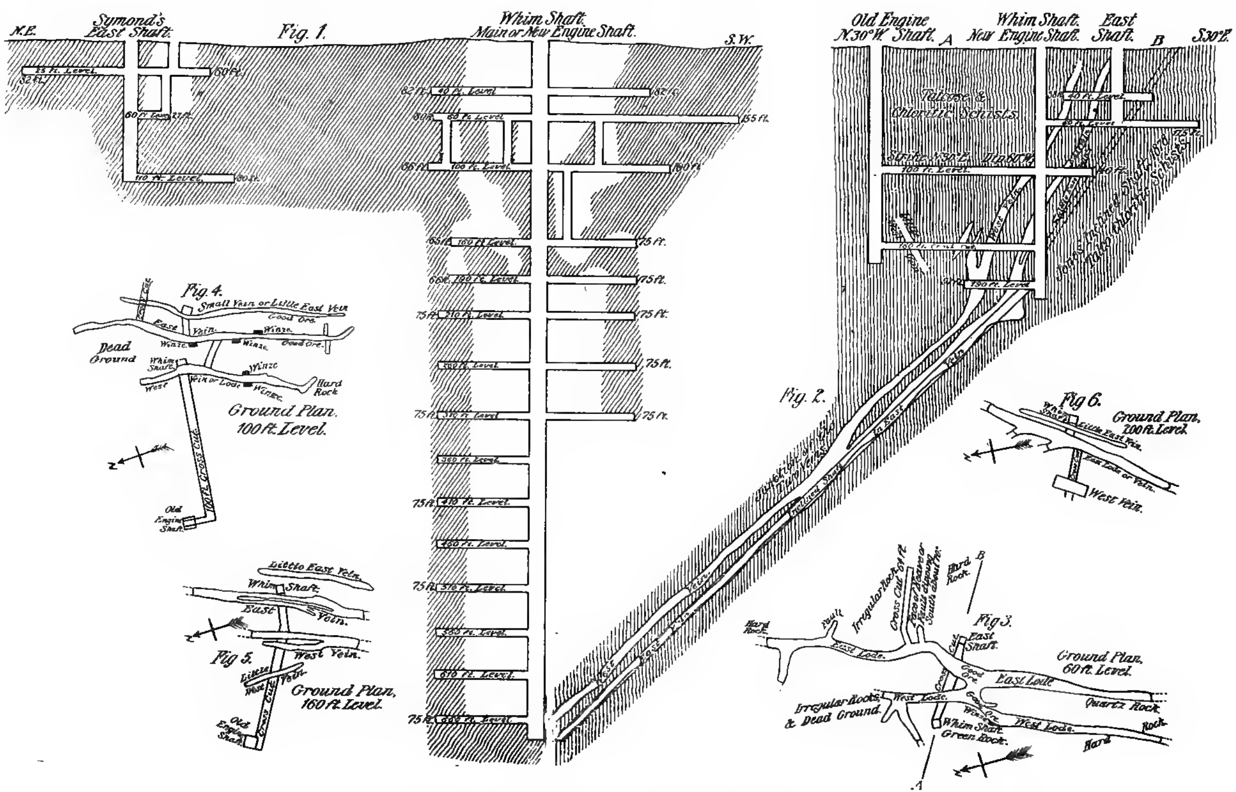
The mine has been more or less prospected for about 700 feet of its entire length, but the vein formation extends a much greater distance.

The prevailing appearance of the upper part of these lodes, and their accompaniments, is a yellowish white, decomposed, talcose material, varying from rock to rotten schist and soft clay, and with the mineral matter dispersed through it, and not readily distinguishable. The treatment of the ores for gold did not continue long, for the real character of the mine speedily disclosed itself.

The East vein above the 60 foot level was the richer in silver, and the West vein in lead, hence the former was called the "Silver vein," and the latter the "Lead vein." The space between was soft ground with disseminated mineral matter.

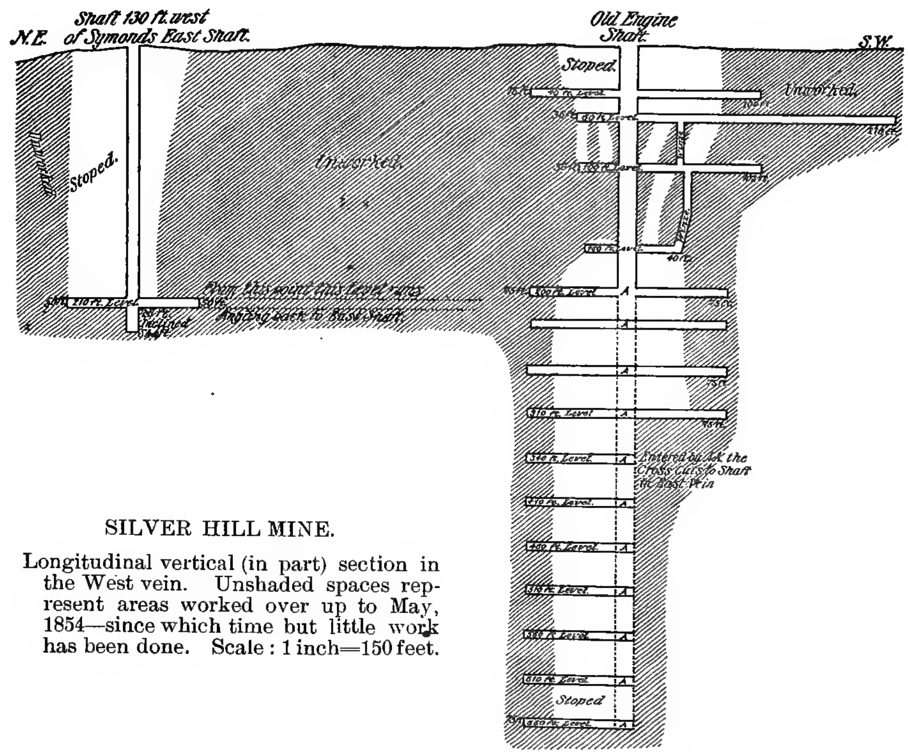
Two small veins are found from 100 to 175 feet in depth; the Little East vein, a few feet east of the main East vein, and nearly parallel to it; and the Little West vein, some 50 feet west of the main vein, and inclining toward it. Small outlying lenticles were encountered occasionally in driving into the "country," and the main vein was occasionally divided by "horses" of slate.

The veins come together at the 60-foot level just to the southwest of the engine shaft (plate XII., fig 2), where the west vein was the richer in silver. At the 60-foot level, and down to the 100-foot level of the West vein, there also occurred a good body of manganese ore, and associated with it most of the cabinet specimens for which this mine was noted; e. g., carbonates, sulphates, and phosphates of lead, and carbonates and silicates of copper, together with foliated and other kinds of native silver; the East vein was less rich in cabinet specimens.



SILVER HILL MINE, DAVIDSON COUNTY.

Unshaded spaces and the grouud plans showing the area worked out up to May, 1854. Scale : 1 inch=150 feet.



SILVER HILL MINE.

Longitudinal vertical (in part) section in the West vein. Unshaded spaces represent areas worked over up to May, 1854—since which time but little work has been done. Scale : 1 inch=150 feet.

The West vein also expands considerably between 60 and 100 feet; but in the expanded parts it was regularly defined, and often had "vugs" with rich mine matter. In this zone the ore was changed from oxides to sulphides, with blende predominating over the galenite. Below the 160-foot level the East vein again becomes richer in silver.

At this depth the space from wall to wall of the two veins (i. e., foot wall of East vein to hanging wall of West vein) is 32 feet, and the vein becomes quite vertical, i. e., 64° from horizontal, and sometimes expands into nests, and is frequently filled with black, cellular, steel-grained, zinciferous ore, with occasional masses of rich argentiferous galenite, and native silver. Assays of this ore show:

SILVER ORE, SILVER HILL MINE, EAST VEIN, DAVIDSON COUNTY.

	(17)	(18)
Silver, per ton	20 oz.	80 oz
Lead	49 per cent.	52 per cent.

Galenite associated with minerals of secondary formation, is sometimes found ranging extraordinarily high in silver.

For 160 to 200 feet the vein becomes still more steep, but at the latter depth rapidly changes to approximately 45°. Near the 200 foot level the west vein is ten to sixteen feet thick, and is filled with argentiferous galenite—the last ten feet having produced more silver than any similar distance from the 160 to the 200 foot level.

The East vein is divided by a "horse," at the 160-foot level, as shown on plate XII. Both the Little East and the Little West veins carry ores quite like those of the main veins at the same depth.

Below the 200 foot level the blende gradually increases, and finally predominates over the galenite.

The composition of a large pile of ore, which had accumulated with reference to smelting, was as follows:

ORE FROM SILVER HILL, DAVIDSON COUNTY.

	(19)
Lead	17.5 per cent.
Zinc	45. "
Sulphur	25. "
Iron oxide, alnmina and silica	10. "

All efforts to smelt this class of ore were disastrous and wasteful.

At 170 feet the richest ore was found in a lenticle in the general mass, two feet thick. At the depth of about 200 feet a huge shoulder

or swell was encountered, making the floor nearly flat for awhile. Below 200 feet the vein and its walls assumed their permanent and normal characteristics.

The inclined shaft was sunk in the East vein, and cross-cuts driven from it to the West vein, and through them the West vein was worked, levels being driven each 50 feet on the incline. Down to 310 feet the levels extended both northeast and southwest; below 310 feet, 50 to 75 feet to the north only, since the shoot of ore appeared to be pitching to the northeast. The stopes extended 25 to 50 feet from the shaft along the levels, both veins being worked alike. At the depth of about 400 feet, the exact point not being now ascertainable, the two veins united again, and continued together for a distance of 50 feet downward.

The ore shoots appear to be diminishing in length at the deepest point thus far attained, and are about 25 feet long in the course of the vein, but the thickness is not materially changed, and they have a width of twelve feet. Those who have been long familiar with the mine, say that it is a repetition of what has often occurred, and are sanguine that it will enlarge again.

It is believed that a large body of carbonates still exists near the surface, and down to 100 or 200 feet. This body was penetrated by the late J. Howard Jones, in 1878, and a large amount of ore brought to the surface. Its character is indicated by assays Nos. 20 and 21 below. The general position of Mr. Jones' inclined shaft is shown on plate XII., by dotted lines; an extensive cave subsequently occurred, and its exact position cannot now be determined.

It may be mentioned that bodies of iron pyrite, with a very little chalcopyrite, are sometimes encountered, and it is believed that a considerable quantity exists. Assays Nos. 22 and 23 show its composition. Nos. 24, 25 and 26 are assays of compact galenite.

No. 27, by Prof. F. A. Genth, is the average contents during his connection with the mine, being an average of some 200 assays.

ORES FROM SILVER HILL.

	CARBONATES.		PYRITE (WITH CHALCOPYRITE).	
	(20)	(21)	(22)	(23)
Gold, per ton	4-10 oz.	1-10 oz.	15-100 oz.	5-10 oz.
Silver, per ton	15 75-100 "	3 6-10 "	1 3-4 "	2 3-10 "
Lead	3.8 per ct.	31.94 per ct.	0.67 per ct.	------
Zinc	------	27.28 "	2.08 "	------

COMPACT GALENITE.

	(24)	(25)	(26)
Gold, per ton	2-10 oz.	3-10 oz.	2-10 oz.
Silver, per ton	2 1-2 "	8 3-10 "	8 7-10 "
Lead	22.94 per ct.	56.72 per ct.	12.57 per ct.
Zinc	7.14 "	....	34.29 "

GENERAL AVERAGE OF 200 ASSAYS, SILVER HILL ORES.

	(27)	
Galenite	21.9	per cent.
Bisulphide of iron	17.1	"
Sulphide of zinc	59.2	"
Silver and gold	.025	"
Copper pyrite	1.8	"
	100.025	"

Passing to the north along the East vein are the Symonds' shafts (plate XII). Sulphide ores were encountered here near the surface, and were of the same general character. Symonds' east shaft was sunk 110 feet, and the west shaft 210 feet. Very little stoping was done in these two veins. A level was driven from near the bottom of Symonds' west shaft, running angling back to the engine shaft in the East vein.

The mine during the thirty years of its active work was practised on by all kinds of "process" mongers, and the grounds and buildings are a museum of old and nondescript machinery and metallurgical appliances.

A mechanical separation of the galenite and blende by buddles and similar concentrating machinery was probably the nearest to success of any of the methods adopted here; but assays of the tailings and slimes show a great waste of valuable constituents.

The improved concentrators now so generally used, would probably go much further towards solving this difficult metallurgical problem and of making all the constituents commercially available.

The ore was for some time used without separation of the galena and blende in making white paint, and served, it is believed, an admirable purpose.

Silver Valley Mine.—This mine lies five miles northeast of Silver Hill. It was discovered and opened in 1880.

The prevailing formation is a silicious argillaceous schist. The con-

tents of the vein is a milk-white and barren-looking quartz, which disclosed little mineral matter until a depth of sixty feet was reached, though the upper part had a little brown ore.

The presence of galenite was suspected thirty years ago, and much prospecting work was done to find the deposit; but the work was done mostly in the schists some distance off to the west of the present shaft, where the galenite disseminated in the schists seemed most promising. The vein now under discussion was subsequently discovered by a shrewd guess. Its strike is approximately north and south, and its dip nearly 45° west.

The vein occurs in the silicious, argillaceous schists, which schist forms the hanging wall, and quartzite (quartz strongly resembling gun flint) forms the foot wall.

The quartz outcrop of the vein is nearly twenty feet wide, and is not the least promising for a mineral formation. The vein is five to twelve feet wide, and presents a laminated structure, with alternate bands of ore, slate and quartz; these ore seams are from three to eighteen inches thick. It is believed that the ore is less scattered and more solid as depth is gained.

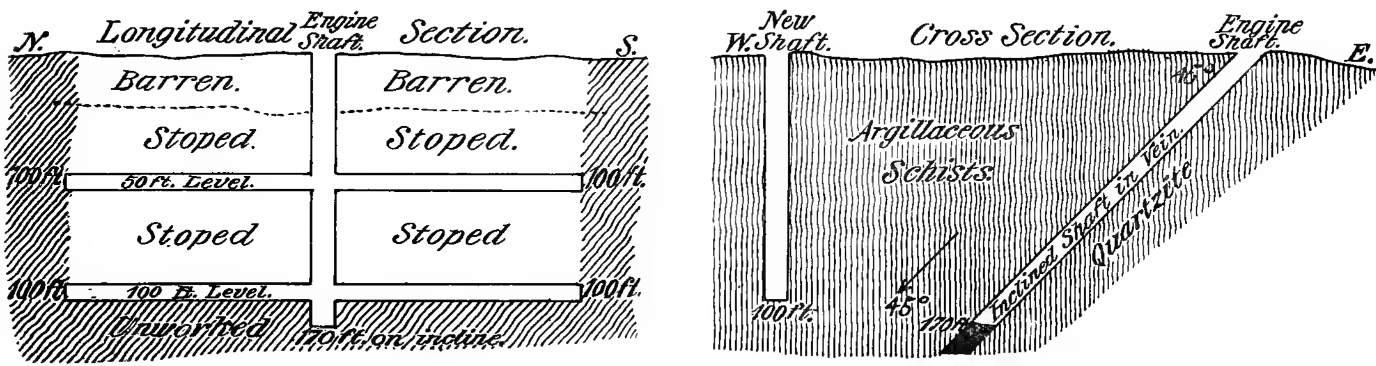
The mine is entered by two shafts, one vertical and one underlay in the vein of 170 feet (equivalent to about 120 feet vertical), and levels have been run 100 feet in either direction from the foot of the inclined shaft, which are mostly in ore. These are shown on plate XIV.

The ore is very like that of Silver Hill in its lower levels, and blende has come to form a large, and in some cases, the predominant constituent of the ore. The subjoined assays will show the composition of the massive galenites (or blendes):

ORE FROM SILVER VALLEY MINE, DAVIDSON COUNTY.

	GALENITES [BLENDES] (28–30).			POOR CONCENTRATES.
	(28)	(29)	(30)	(31)
Gold, per ton	trace.	2-10 oz.	trace.	2-10 oz.
Silver, per ton	13.30 oz.	136 1-2 "	29 1-2 oz.	17 8-10 "
Lead	15.54 per ct.	55.25 per ct.	38.8 per ct.	11.18 per ct.
Zinc	31.43 "	11.24 "	32. "	27.70 "

	GOOD CONCENTRATES.	SECOND CONCENTRATES FROM "POOR" ORE.
	(32)	(33)
Gold, per ton	2-10 oz.	5-100 oz.
Silver, per ton	34 6-10 "	10 12-100 "
Lead	47.62 per cent.	9.63 per cent.
Zinc	12.68 "	27.84 "



SILVER VALLEY MINE, DAVIDSON COUNTY.

Unshaded spaces show the extent of the mining operations up to January, 1883. Scale : 1 inch=75 feet.

SECOND CONCENTRATES FROM SOLID ORE.

	(34)
Gold, per ton	8-100 oz.
Silver, per ton	11 9-100 "
Lead	8.13 per cent.
Zinc	33.54 "

Assay No. 28 more nearly represents the common run of the slightly cobbed ore, and No. 30 the massive ore; No. 29 is exceptional.

The possibility of concentrating the mine stuff into a smelting product fairly free from zinc is shown in No. 32, but the losses, as concentration has hitherto been practiced, are enormous.

The gold is far from being uniformly diffused, for the presence of a little iron pyrite makes a considerable difference in the gold contents of the concentrates.

This mine has the appearance of a good future before it.

Welborn Mine.—The Welborn (Smith) Mine is in Davidson county, two miles west of Silver Hill, carries like complex ores, and ore assays show a similar tenor.

Developments thus far very imperfectly indicate its resources.

Some other points in this section and belt show slight appearances of deposits of galenite, but if of value the fact has not been demonstrated.

Steel Mine.—This mine lies in Montgomery county, some ten or twelve miles east of this belt. Its grouping and lithology will be given in the section on gold ores.

It is on the east side of Uwharrie River, and about two miles southeast of Eldorado village.

The metamorphic (Huronian) schists are quite like those of the Russell Mine—chloritic, quartzitic, argillaceous, talcose; but the quartzitic characteristic is also prominent here. The ore beds have apparently undergone still further alterations, which have enriched them. The vein is a bedded one, i. e., one of the series of strata charged with ore, and differentiated from the "country" chiefly by its extreme alterations, and more concentrated mineral matter. The formation itself is auriferous to a great extent. The ore deposit varies from nine to twelve feet in thickness, and occasionally rises to twenty feet. Its strike is nearly north 25° east, and dip northwest about 70°, becoming more perpendicular as depth is gained.

The most valuable part of this deposit consists in what is locally called "string veins"—narrow seams of ore, which run through the mass with some general conformity to the beds. There are usually several of these strings approximately parallel, and form a line to nearly twelve inches in thickness. The combined thickness of these seams is rarely less than 15 inches, and is sometimes more than three feet. There is a considerable proportion of the gold so far dissociated from the mineral matter as to be easily amalgamable, but a very large part is so closely connected with the sulphurets as to be refractory to any mere mill process, and will need a smelting treatment; the associated mineral matter is galenite, blende, chalcopyrite, and pyrite. The rich ores of this part of the vein have ever since the mine was worked been called "No. 1" ores, and are so alluded to in all reports.

The rest of the deposit has a very small but varying proportion of sulphurets, pyrites, chalcopyrite, and galenite, and are generally rich enough to justify the treatment of the entire mass. This ore is known as "No. 2." No. 1 ore, as may easily be seen, is frequently of great value; some assays not unfairly represent working averages of the ore at shallower depth; they are by Prof. F. A. Genth, to whom, with E. Hausser, E. M., and Dr. Charles T. Jackson, we owe nearly all that can be trusted respecting the upper levels of the mine.*

"NO. 1" ORES, STEEL MINE, MONTGOMERY COUNTY.

	(35)	(36)	(37)	(38)
Gold, per ton	20 75-100 oz.	27 32-100 oz.	128 12-100 oz.	467 62-100 oz.
Silver, per ton	undetermined	7 76-100 "	39 50-100 "	117 20-100 "

"NO. 2" ORES, STEEL MINE, MONTGOMERY COUNTY.

	(39)	(40)	(41) [average of 7 feet.]	(41a)
Gold, per ton	1 28-100 oz.	2 67-100 oz.	1 9-10 oz.	7 83-100 oz.
Silver, per ton	1 96-100 "	1 61-100 "	not determined.	3 56-100 "

Assay No. 41a represents the vein at the depth of 65 feet, throughout its entire width.

An examination of these figures will justify the early reputation of the mine for richness.

As a matter of course the most ardent friends of the mine do not claim any such values for the ores at the present depth (220 feet); nev-

* John T. Cramer, Esq., of Thomasville, has added many valuable notes respecting the later work.—G. B. H.

ertheless, very rich pockets are even now found, which emulate these amounts, and the average values of the working ores are satisfactory.

There can hardly be a doubt that, the supply of material is amply large, for very extended operations.

The vein has been traced for more than a mile; and it is believed that there are parallel bodies of ore, but the hitherto abundant supply has left no inducement for a thorough cross-cutting, which alone can prove this.*

The mine is operated by the Genesee Gold Mining Copany, with 40 stamps. The method hitherto pursued is amalgamation of free gold, and concentration of the sulphuretted tailings for metallurgical treatment.

Henderson Mine.—This mine, near Eldorado village, Montgomery county, is merely a string of prospecting pits; and of the deposit nothing certain can be said, on account of the slight developments, though the mine matter had something of promise at the very start.

Galenite (and blende in still smaller quantity) is sometimes found in the ore of the *King's Mountain Gold Mine* in Gaston county, where it is generally rich in gold.

The *Baryte Mines* along the east flank of the King's Mountain range from Crowder's Mountain to Yorkville, S. C., occasionally carry a small amount of blendy galenite, (the blende sometimes predominating over the galenite) which contain small quantities of gold and silver. The following assay shows that they are not generally of any great metallurgical value:

BLENDY GALENTINE, BARYTE MINE, GASTON COUNTY.	(42)
Gold, per ton	6-100 oz.
Silver, per ton	24-100 "

The range of limestone alluded to above as accompanying the iron beds of Gaston, Lincoln and Catawba counties, has at times a little galenite, etc., but the amount is not commercially important:

LIMESTONE, GASTON COUNTY.	(43)	(44)
Gold, per ton	1-4 oz.	trace.
Silver, per ton	1 43-100 "	12 3-10 oz.
Lead	31.35 per cent.	

* It is entirely in accordance with the analogies of such formations that there should be such parallel bodies, as may be seen at the Russell Mine.—G. B. H.

No. 43 is from Keener's Lime quarry, and No. 44 from the same neighborhood.

Flint Knob Mine.—At Flint Knob, in Wilkes county, argentiferous lead ore is also found. The locality is in the western part of the county, six miles east of the Deep Gap of the Blue Ridge, and therefore not far from both Watauga and Ashe counties. The property is situated on a mountain spur that shoots off from the Blue Ridge at intervals, and extends with gradually diminishing sharpness of outline and altitude to the Yadkin River. This particular spur is called the Laurel Spur, and further down, Flint Knob, from the abundance of quartz which covers it. The earliest settlers were aware that lead was to be found here, but extended explorations were undertaken only some 50 years ago, by Dr. McKenzie, and later by Gen. S. F. Patterson.*

The galenite is scattered more or less sparingly in a quartz gangue. Assays by Adelberg and Raymond showed samples to contain:

ORE (45) AND CONCENTRATES (46), FLINT KNOB MINE.

	(45)		(46)
Lead	19.5 per cent.	Gold	$81.57
		Silver	7.33
		Total	$88.90

Five tons of ore made one ton of concentrates.

Specimens of the ore may be seen in the State Cabinet at Raleigh.

The best specimens that have been obtained of late years were found in a prong of Noah's Branch, on the northeast side of the knob, in a quartz vein that lies in mica schist. The vein is said to be from 20 to 30 inches thick, but sufficient work had not been done to justify an assertion on this point.

There are also a few localities in McDowell county, near the east foot of the mountains, where galenite is found.† The better known of these localities are the Queen Mine, Cedar Cove, and the Dobson Mine.

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* These facts are due to the kindness of C. J. Cowles, Esq.

† The late Mr. E. H. Bissell, a man of large information and experience in mining matters, said: "There is a stretch of lead mines (with gold and silver) in McDowell county, commencing near the Rutherford line at Mumford's Cove, and running toward the northeast. The *Baker Mine* is in this stretch; the veins are *very* promising, wide and persistent, but have never been exposed."

Alfred K. Weaver, Esq., of Marion, has also added a few facts.

Baker Mine.—This mine is located in Caldwell county, 12 miles nearly north of Morganton, and is on the east side of Johns River.*

The geology of the locality may be indicated in few words. The formation is the common crystalline schists and gneisses of the section, which are generally described as talco-micaceous; they are also frequently auiferous. The gneiss is occasionally hornblendic, with a great preponderance of feldspar.

A belt of serpentine traverses the tract from northeast to southwest, and with a width of 75 or more feet. It is traversed in all directions by cracks or seams, which divide it into large irregulr blocks, and to some extent also by veins of chrysolite or amianthus, which usually convert it into a uniform network.

The schists strike northeast and southwest, and dip eastward; the serpentine also strikes northeast and southwest.

The veins are in the schist, and run nearly at right angles to the serpentine (i. e., nearly northwest and southeast). It is not certainly known whether they continue into and across the serpentine.

There are four veins, with indications of others. The more northerly vein is the Brasswell, which has a large, boldly projecting outcrop, but has never been much examined. It bears N. 35° W., and apparently dips N. E. about 60°; its width is 2 to 5 feet; the vein-stone is quartz.

The Goley Ann vein bears N. 39° W., and dips N. E. 70°; its width is narrow at the surface; vein-stone quartz, with ferrugineous matter.

The Shaft vein is next to the southwest. Its strike is N. 45° W., and dip N. E. 66° to 75°; it has been opened at points 200 yards apart. The vein is 20 to 24 inches wide. The vein-stone is quartz, with scattered galenite and associated minerals.

This vein is opened both by a pit and by an adit.

The Cabin vein is still further south, and was worked at points 100 yards apart; it bears N. 35° W., dips N. E. 60°; width 20 inches. The vein-stone is quartz, with ferruginous matter and galenite in considerable quantities.

The quantity of galenite is thought to be greater in the Shaft vein.

Together there is about three-fourths of a mile of veins.

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*Many of these facts, and copies of Reports are from C. J. Cowles, Esq., who visited the mine in October, 1857, in company with Prof. Emmons, then State Geologist. The mine was then in full operation. Prof. Emmons freely imparted the result of his observation to Mr. Cowles, and these, together with his own observations, are now the chief sources of our knowledge respecting this locality.—G. B. H.

The galenite is highly auriferous as well as argentiferous. Assays by J. G. Ellery give :

GALENITES, BAKER MINE, CALDWELL COUNTY.

	SHAFT VEIN—2 ASSAYS. (47)	CABIN VEIN. (48)
Gold, per ton	4.224 oz.	1.645 oz.
Silver, per ton	16.433 "	67.975 "
Lead	84. per cent.	83.5 per cent.

The quartz of all the veins, aside from the galenite, carries gold.

The surface, and particularly the gulches and streams, were originally rich in placer gold.

The Peach-Bottom Mine.—The Peach-Bottom (or Maxwell) vein, in Allegheny county, was originally worked as a lead mine, but at a very shallow depth the ore changed to copper, and for a long time it was operated for such. Its ores, when last worked, commonly showed a small percentage of galenite, but as a commercial constituent it could not be regarded as important. Further notice of this mine is given at another place.

Dr. F. A. Genth* is authority for saying that lead occurs at Marshall, Madison county; Clayton, Johnston county; Elkin Creek, Surry county; at several of the copper mines of the State; at Murphy, Cherokee county, and on Beech Mountain, Watauga county.

It will be evident, from the representations made in this section, that the resources of the State in these metals is not large.

Silver ores, separate from lead, are wanting. The argentiferous galenites are rarely rich in silver, and most often these galenites (particularly from the mines and from the section, on which the greatest reliance must for a long time be placed), have so large a proportion of zinc as to be more properly classified as zinc ores. They are likely to find a somewhat restricted sphere in the smelting processes.

How far other localities (from which the galenite is relatively free from zinc), will make this deficiency good, is largely a matter of conjecture, but the supply will not apparently be large, and will be very uncertain, and its uses in the working of the precious metals quite limited. The proximity of the lead belts of Virginia and of East Tennessee may partly obviate these deficiencies, but not entirely, as these galenites are commonly non-argentiferous, or practically so.

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* See Kerr's Geology of North Carolina, 1875, p. 291; and chapter 1 of this volume, p. 18.

SECTION 3. COPPER.

Dr. Emmons brought the description of many of the copper mines of North Carolina down nearly to the time of the war, since which time little has been done, except at the Davidson (Emmons) Mine at Conrad Hill, in Davidson county, and at Ore Knob, in Ashe county. Very few of these old mines have since been reopened, and there is need of little discussion of the localities he described.*

The copper mines known to him were, for the most part, in the central syenitic belt (classed provisionally as Lower Laurentian), or in the Huronian schists ("slates") immediately to the east. Of the copper veins in the western part of the State there was then no exact knowledge.

ORES OF THE SYENTIC BELT (LOWER LAURENTIAN).

Most of the districts in this central belt have mines in which copper is the predominant useful metal, or in which it occurs in sufficient quantity to be an important adjunct.

There are in Guilford county a few mines, which have been very productive in this metal. Prominent among these are the Gardner, 6 miles, and the North State, 8 miles southwest of Greensboro; the Lindsay, the south extension, and the Jack's Hill, the north extension, of the North State; the Twin Mine, 6 miles southwest; and the North Carolina (Fentress), 5 miles southeast of Greensboro; and the Gardner Hill, 3 miles east of Jamestown.

Only the general characters of these places will be alluded to, as some discussion of their relations will appear in the section on gold. The facts here stated are taken from Emmons, with some condensation and re-arrangement.

Hodges Mine.†—Hodges (Hodgins) Hill Mine, is in Guilford county, near the Fisher Hill.

The gold is distributed unequally through a heavy vein, and in quartz and chalcopyrite; the vein is from 6 inches to 12 feet wide, and is very flat. The minerals taken out are very large and fine

* Geological Report of the Midland Counties of North Carolina, 1856, pp. 196–208.

† Emmons' Report on the Geology of the Midland Counties of North Carolina, 1856, p. 173.

quartz crystals, peroxide of manganese, limonite, siderite, hornstone, malachite and earthy red oxide of copper.

*North Carolina Mine.**—This mine, sometimes called the Fentress, has been traced at least three miles by its quartz outcrop. The two extreme shafts are ¾ of a mile apart; the northwestern is called the Worth shaft. The strike of the vein is N. 25° E.; its dip is variable, ranging from 38° to 60°; but neither the course nor the dip is constant. It is on the eastern edge of the Laurentian belt. At the Worth shaft, at 40 feet in depth, the vein is 3 to 4 feet wide.

In the lowest level, at 310 feet, the fissure is 7 to 8 feet, and in places 13 feet wide, but there is no improvement in the vein where it is expanded; it carries about the same amount of copper as a 7 or 8 foot vein. It is notorious in this mine that the lode of copper shifts its position; lying for 30 or 40 feet on the foot, and then, sometimes with and sometimes without a curve, it is found on the hanging wall.

In addition to the shoots, the ore is found disseminated sparsely in the vein-stone.

The shoot of ore in the 310 foot level was 80 to 90 feet long, and approximating 34 inches in thickness. The fissure is well developed, and is sufficiently wide.

Gardner Hill Mine.†—This mine is in Guilford county, 3 miles nearly east of Jamestown. There are supposed to be three veins on the property. The main vein has been worked to a depth of 110 feet. The vein fissure varies from a few inches to three feet; the vein-stone is quartz; the lode is bounded by slates or "killas"; the granite on the foot wall is tough, but on the hanging wall is soft. The ore contains quite a large quantity of rich sulphuret of copper and iron, but it is not largely mixed with iron pyrite at any point of the vein.

Twin Mine.‡—This mine is in Guilford county, six miles southeast of Greensboro. It derives its name from the fact that two parallel veins are exposed in one tunnel. The veins have a strike N. 40° E., with a southeasterly dip. The vein is about 18 inches wide, consisting of quartz thickly interspersed with chalcopyrite. The several strings of ore consolidate to a vein at a depth of 60 feet.

The Raleigh vein is a continuation of the Twin.

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* Emmons' Geology of the Midland Counties of North Carolina, 1856, p. 197.

† The same, p. 174.

‡ The same, p. 203.

North State Mine.—This mine was described by Emmons* as the McCulloch, and is still sometimes called by that name. It is located in Guilford county, two miles south slightly east from Jamestown.

The vein fissure pursues a northeast course, but is curved in the middle. It dips at an angle of 45°.

The vein is composed of a column of brown ore resting on the foot wall, and extending downward 130 feet, when the unaltered ore appears.

The vein at the surface is about two feet wide; at 90 feet below, it is 10 feet wide; at 130 feet, it swells out into a rather lenticular form, with a thickness of 24½ feet. Here the ore is concretionary; on the foot wall is the brown ore only six inches thick, then copper pyrites, then a belt of brown ore, the middle of which is rich; upon the hanging wall is the principal mass of porous quartz, which is generally poor. The average yield of the brown ore is $1.50 per bushel, and occasionally $5.00. At the southwest the vein runs into the Lindsay property. To the north is a ravine, and beyond it, ⅓ of a mile, is the *Jack's Hill Mine.* Here a shaft 77 feet deep exposed a vein of very great width, and a vast quantity of valuable ore.

The copper ore of the North State is the purest sulphuret; the gold is carried in combination with sulphurets.

The latest work was mostly done at the depth of 392 feet (about 325 feet vertical). The vein at this depth varies from 4 to 8 feet in width. In the lower levels the ores are mostly sulphurets, sometimes massive, but more generally scattered in a quartzose gangue, and require a cobbing or other concentrating. The ores carry a small per cent. of copper, and are commonly of a good grade in gold.

The mine has latterly been worked for gold, but the copper has been neglected. This mine material in its concentrated form ought to receive a smelting treatment.

It is the only locality in this group which has been largely worked, and is equipped. The equipment consists of twenty stamps, and all necessary machinery for effective work.

All of the above mines are in the syenite, near its eastern contact with the schists, and therefore favorable to a large contents of mineral matter. Large bodies of ore were extracted, but the result of the deeper workings was not, so far as copper was concerned, as favorable as that of the upper levels.

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* Geology of the Midland Counties of North Carolina. 1856, p. 170.

It is much to be regretted that records and maps have not been preserved, so that the exact facts might be known as a basis for future work. One other circumstance enhances this regret. It has now become evident that the just and profitable development of the auriferous resources of the State will compel ultimately large metallurgical operations, in which copper ores will play an important part, and a steady and large supply will be essential. This district undoubtedly will then be an important one, if the early output correctly indicates the deeper mineral stores.

In Cabarrus county both Emmons* and Genth† regarded the Ludowick, Boger and Hill mines as carrying a considerable amount of yellow sulphuret of copper, and as likely to be productive.

The *Phœnix Mine*, now worked for its gold, carries a small percentage of chalcopyrite, but not a sufficient quantity to justify any special effort to save it.

Other veins may be mentioned in the neighborhood, which also promise a store of copper ore below, viz.: Orchard, Vanderburg, &c.

The *Pioneer Mills Mine*, in the southern part of Cabarrus county, is also a promising point. According to Dr. Emmons' observations,‡ "it is a belt carrying numerous veins of gold and copper------the great quantity of ore, and the ease with which it is obtained, confer a great advantage upon it." No work has been done here since this description was written, and nothing more can be said of it. The debris about the mine indicates the abundance of the cupriferous material.

The *Morrison Mine*, 1 mile distant, may also be mentioned as another locality which promises well for copper. The *Crosby* (or *Poplan*) *Mine*, and the *Rogers Mine* are in this neighborhood; and apparently, both of them have large bodies of ore.

In Mecklenburg county, the mines which have been chiefly noted for copper are:

The Ray (Baltimore and N. C.), Ferris (Faires), McGinn, Kerns (or Hopewell), G. C. Cathey, McLeary, Cathey, and some others little

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* Emmons' Geology of the Midland Counties of North Carolina, 1856, p. 202.

† Kerr's Geology of North Carolina, 1875, p. 279.

‡Geology of the Midland Counties of North Carolina, 1856, p. 178.

known. The McGinn, the Cathey and the Kerns have at different times been worked for the copper contents to the exclusion of gold.

Cathey Mine, five miles southwest of Charlotte, when worked, gave a very large body of chalcopyrite, which was shipped from the State for reduction. A depth of 75 feet was attained, when the bottom was thought to be unfavorable, and the work was suspended.*

The *McGinn Copper Vein,* 5 miles west of Charlotte, is one of a series of veins on a large mining tract. The main vein is auriferous, but one of the cross veins or feeders is known as the Copper Vein, and was operated extensively for that ore to a depth of 110 feet—as far down as could readily be done 40 years ago, with the appliances then at command.

The ore was the yellow sulphuret, and was shipped from the State.

The *Kerns Mine,* sometimes known as the Hopewell Mine, is in Mecklenburg county, 11 miles northwest of Charlotte. It is one of the properties that promised well, and yielded liberally. The last work was done at the depth of 140 feet, when the death of both the superintendent and the manager brought the work to a standstill. Conflicting statements have been made respecting the amount and value of the ore at this depth.†

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*It is one of the empirical maxims of miners in the section, that when the blue rock or blue granite comes in, the end of the mine has come. How far this is true, I am unable to say, but in some cases within my personal observations it was entirely untrue: as for example, at the Capps and the St. Catherine, where good and large bodies of ore were found below it. It is true that for a time the deposit was affected, narrowed and bent out of its normal course. It is quite possible that the unfavorable statements of "being squeezed out in the bottom," may be explained on similar grounds.

This blue rock or granite defies classification, as it varies materially at different points in the same mine. The subjoined analyses will show the contents:

ANALYSES OF "BLUE GRANITE," CAPPS MINE, MECKLENBURG COUNTY.

	(49)	(50)	(51)	(52)	(53)
Silica	66.03	55.90	74.80	57.20	70.30
Alumina	19.	15.27	6.66	9.36	5.93
Protoxide iron	5.10	15.30	6.27	9.94	6.13
Water and loss on ignition	2.90	8.20	4.05	8.95	7.45

All of these specimens were taken from the Capps mine, and from points where they had deflected the vein out of its course.—G. B. H.

† The manager stated to me that at 80 feet depth there were two veins aggregating five feet, and that at 140 feet there was a 2-foot vein of good yellow copper ore.

G. B. H.

There is on the *Dunn Mine* tract, 90 miles north of west from Charlotte, a vein—the East vein—reported to be good for copper. It was worked at the outset for gold. As the latter became very difficult to amalgamate, work was discontinued. This mine is more particularly described under the head of gold.

Among other mines, which carry enough copper in the upper part to give grounds for belief that copper ores may be found in some abundance at greater depths, are the Ray (Baltimore and North Carolina), Ferris, G. C. Cathey and Mr. Leary's. Assays of ore from these Mecklenburg county mines are as follows:

	KERN'S MINE (54–56).			CATHEY MINE (57, 58).	
	(54)	(55)	(56)	(57	(58)
Gold, ounces per ton	6-10	2-10	8-10	16 505-1000	75-100
Silver, ounces per ton	trace.	trace.	85-100	11 27-100	2 69-100
Copper, per cent	17.08	18.83	12.23	.30 ?	.13 ?

	MCGINN MINE (59, 60, 61).			G. C. CATHEY MINE (62. 63).	
	(59)	(60)	(61)	(62)	(63)
Gold, ounces per ton	1-4	525-1000	600-1000	4-10	35-100
Silver, ounces per ton	1 35-100	1 28-100	93-100	95-100	3.00
Copper, per cent	7.50	4.55	8.05	14.84	25.4

Nos. 54, 55 and 56 are from the Kerns (Hopewell) vein; Nos. 57 and 58 are from the Cathey vein; Nos. 59, 60 and 61 are from the McGinn vein; Nos. 62 and 63 are from the G. C. Cathey vein.

It is very difficult to do justice to this central belt in respect to the occurrence of copper. A few considerations will show why so little is known of these underground stores in this section. The occurrence of copper ores, unless they were of such exceptional richness as to bear costly land transportation, had no market; low grade copper ores, which (in sections favored with cheap transportation, or near commercial centers,) could be easily beneficiated by concentration, were here valueless; and as it was found by experience that the presence of copper greatly hindered the amalgamation of the gold ores, for which these mines were in every case originally operated, the presence of any considerable amount of copper was the signal for abandoning the mine.* A map of the underground work was very rare, and now our knowledge of these places is almost gone, as details are but vaguely retained in the memories of the older miners.

*It is also true that copper pyrite, as a rule, does not carry as much gold as the kindred iron pyrite.—G. B. H.

It is not probable that the ores of copper are likely to be of importance for the exclusive production of that metal in the present condition of the copper market; but in a smelting treatment of the gold ores of this section, one of two methods will apparently be a necessity: smelting by lead ores (lead smelting method), or by copper ores (copper matte method).

Considered in this light the command of a large supply of auriferous copper ores is almost vital to the prosperity of the gold mines of central North Carolina; indeed, some very promising enterprises have come to naught, from fear that the resources in this respect might be wanting.

Occasional bunches of copper pyrites are found in all the gold mines in the section, and might be readily picked out for special uses.

Copper Ores of the Central Huronian Belt.

There are several mines in the Huronian belt, to the east of the syenite belt (Lower Laurentian).

The Conrad Hill Mine, of Davidson county, 7 miles a little south of east from Lexington, is one of the copper bearing gold mines of this region. The ores are both auriferous and cupriferous. For the greater part of the dip of the mine the properties have been worked for gold; and the mine is described in detail in the section on gold.

The Gold Hill Mines.—At Gold Hill, Rowan county, both the Barnhardt and the Randolph mines, which are described under the head of gold, have had copper pyrite from the moment the unaltered ores were encountered.

No serious effort, however, was ever made to utilize it, since it was not commonly rich enough in copper to make it an ore suitable commercially for smelting, and was moreover more valuable for the gold contents.

It is impossible at this writing to say what resources may still be in the upper levels so far as contents are concerned. The lowest level, at 740 feet, carries considerable bodies of auriferous pyrites containing, according to Mr. Hemby, a late assayer to the company, about two per cent. of metallic copper. As the pyrite is mixed with a considerable amount of slaty and quartzose gangue, it is evidently capable of concentration, by which a product may be attained of some value in smelting, especially when it is taken into consideration that there is an enrichment in gold at the same time.

The following assays will show the mineral character of these pyrites:

AURIFEROUS COPPER PYRITES, GOLD HILL MINE.

	(64)	(65)	(66)
Silica	52.30 per cent.	....	....
Copper	.85 "	2.59 per cent.	5.96 per cent.
Sulphur	16.80 "	....	....
Iron*	23.00 "	....	....
Gold, per ton	1 1-4 ounces.	20-100 ounces.	275-1000 ounces.
Silver, per ton	38-100 "	55-100 "	1 75-100 "

It will be seen that there is room for a concentration of two or two and one-half tons of raw ore into one ton of concentrates.†

If the general belief of the underground resources be correct, it is evident that extended work would produce a steady supply of material for smelting.

Among a large number of other veins in this district, which carry copper at the outcrop, are the Townsend vein, (see topographical map of Gold Hill), worked at one point to 135 feet in depth, with a reported increasing amount of copper at the lowest levels; the veins known locally as " Vein No. V," and " Gold and Copper veins No. VII," and " Standard or Open Cut." This last has shown the greater resources for copper, as far as prospected, though only penetrated to a depth of 80 feet—where the vein is 30 feet thick.

Other memoranda respecting these mines will be briefly set forth in the section on gold, where the district is treated of as a whole.

Of the *Spencer Copper Mine*, in Randolph county, mentioned by Emmons (Geology of Midland Counties, p. 206), no additional information is at hand. The depth reached was 70 feet.

The *Sloan Mine* is in the forks of Deep and Rocky Rivers, one mile from each. The vein is two feet thick, and has been worked to a depth of 40 feet. The ore is chalcopyrite.

The *Clegg Mine*, in Chatham county, has been followed down to 200 feet. The vein is quartz with copper pyrites in talco-argillaceous and talco-quartzitic schists. Much of the vein-stone is a talco-siliceous

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* About one-third of the iron was present as oxide in the chlorite schist.

† It is proper to add that the above samples were drawn in the endeavor to settle a lithological point, rather than to obtain a strict average for gold contents, and hence probably rather underestimate the value of such ores for gold.—G. B. H.

and argillaceous breccia, of a gray and bluish mottled appearance. The vein is traceable for hundreds of yards by large outcrops of white quartz. Its width is from 3 to 6 feet. Calcspar, in hexagonal prisms, and also in curved plates enclosing masses of bituminous coal, occurs in the vein; fine specimens of azurite are also found.

There is an interruption in the vein by a fault or cross course, by which the vein is thrown to the east about 25 feet; otherwise the vein is reported to be unusually regular in its course, continuity and width. Its average thickness is from 4 to 5 feet, and it descends nearly vertically.

The Emmons (or Davidson) *Mine*, in Davidson county, 9 miles east of Lexington, was reopened and worked several years after the war by a Baltimore company. The Hunt & Douglas (old) process was used here successfully for a long period. The available supply of ore was exhausted, according to the statement of James E. Clayton, then superintendent of the mine, and the mine was closed.

Within two or three years it has been again opened by still another Baltimore company, which claims to have discovered some new bodies of ore.

This mine is entered by two shafts 680 feet apart, and both in the lode, which dips westward about 50° from the horizontal. The deepest shaft is 416 feet deep on the incline. Levels occur at 200, 280, 350 and 410 feet. The course of the vein is about N. 20° E.

The vein is 3 to 8 feet wide; ore chalcopyrite, only slightly auriferous. It has been worked exclusively for its copper contents. There is very little iron pyrites present, and (as the mineral matter is almost exclusively yellow copper ore), it is susceptible of being dressed up to a good and desirable grade.

The schists are in appearance almost identical with those of Gold Hill, and the mine is near, if not directly on, the same line.

The Cid Mine is 1¼ miles northeast of the Emmons, and is thought to be on the same lead. The direction, the appearance of the schists, and the general character of the ore, combine to favor this supposition.

It carried from the start rich copper ores: chalcopyrite, with black oxide and other surface alterations.

The tract of land is not large, but it is of such a shape as to allow 1,600 feet of vein.

The surface ore carried from 5 to 15 ounces of silver, with a little gold (for which it was at first worked, but without much success).

An underlay shaft was sunk 100 feet, when, from some unascertained cause, work was stopped.

At the *Foust Mine*, in Alamance county, at the south foot of Bass Mountain, both copper and galena are found in a bluish-green chlorite vein. It has been worked to a depth of 78 feet.

The Chick Mine, in Chatham county, is one mile north of Deep River. The body of ore has been sunk upon to a slight depth, but without much judgment, and has been so slightly explored as to be practically unknown.

The external indications of copper are especially marked, and the entire body is seamed and stained with the blue and green cupric carbonates, which give the surface material a richness much beyond the reality. So far as examined this results from the alteration of the black sulphuret of copper (chalcocite). Assays of ore from this mine are as follows:

ORES FROM THE CHICK MINE, CHATHAM COUNTY.

	(67)	(68)	(69	(70)	(71)
Gold, per ton.........	45-100 oz.	9-10 oz.	3 oz.	4-10 oz.	75-1000 oz.
Silver, per ton.......	7 92-100 "	6 6-100 "	16 52-100 "	68-100 "	1.00 "
Copper, per cent......	17.4	50.3	37.62	0.12	... ..

It is a matter of grave doubt if any of these assays correctly represent the average contents of the deposit.

The Phillips tract, 2½ miles northeast of the Chick, is quite similar. It has been superficially examined by shallow pits, which everywhere show cupriferous material, but at no place very much; specks of chalcocite are disseminated through the rock. The ore always contains gold and silver, but not in workable quantities.

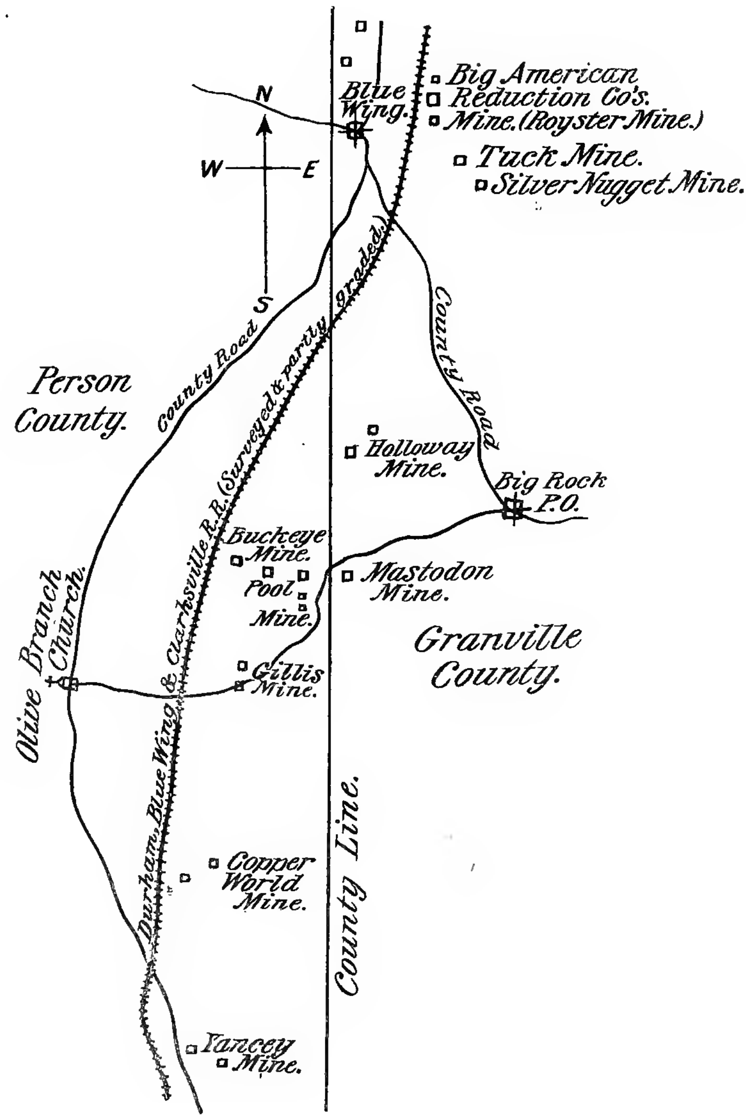
Copper Ores of Granville and Person Counties.

Another interesting belt of copper mines is found in Granville and Person counties. The location of the mines is shown in plate XV.

This region was barely alluded to by Dr. Emmons*, and not mentioned in the Report for 1875.† It was thought by Emmons that it

* Geology of the Midland Counties of North Carolina, 1856, pp. 344, *et seq.*

† Kerr's Geology of North Carolina, 1875.



COPPER DEPOSITS OF GRANVILLE AND PERSON COUNTIES.

From a map by C. W. Edgecumbe. Scale: 1 inch = 1½ miles.

might prove to be 5 miles in length, but later explorations would indicate a length of not less than 8 miles, reckoning from the northernmost point where copper has been found (about 1½ miles north of Blue Wing, and adjacent to the Virginia line), to Yancey's mines, in Person county, on the south.

The section is extremely interesting, and cannot be dismissed without an extended description of the localities, and the characteristics of the veins, where exploitation is now going on, and also of the ores, together with whatever may be promising and interesting.

It must be premised that exploitation is not yet advanced enough to allow of more than approximate statements.

Evidence of the occurrence of mineral matter is first observed, as stated, about 1½ miles north of Blue Wing, in Granville county, and just south of the Virginia line. The belt is almost entirely confined to a ridge, which, with some bends, runs in a course S. 15° W., some thirty miles, nearly to Durham. This ridge, although of no great height, is a somewhat prominent feature in the landscape, and slopes very gradually both to the eastward and westward, and is everywhere strewn with abundant fragments from broken down quartz veins or seams, showing that the agency which formed the veins was very active. Surface indications of ore are of frequent occurrence.

The schists are very hard and siliceous, and change almost imperceptibly into quartz, and *vice versa*.*

The schists adjacent to the vein sometimes shade gradually into ore, as does also, on the other hand, the ore into schist.

The strike of these schists is from N. 10° to 20° E., and the dip 70° to 80° eastward.

The different veins cannot be brought into one alignment, but occupy a belt which at several points is about one mile wide. The topographical sketch, by C. W. Edgecombe, accompanying this description (plate XV), will show the relations.

The proposed railroad from Clarksville (Virginia) to Durham (N. C.), which is now being graded, is on this ridge, and no one of these mines is more than three-fourths of a mile distant from its route.

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*Dr. Emmons, in the paragraphs alluded to, describes the immediate formation as "argillaceous slates;" I regard them as decidedly chloritic, though "argillaceous slates" do occur. Typical chlorite is found near, and sometimes even in the vein stone; the schists are much altered, and the classification is by no means easy; probably only a microscopical study of sections would decide the matter.—G. B. H.

About Blue Wing are the following points: One mile north, a locality where native copper has been found; and half a mile still further north a pit supposed to be on the same vein. Half a mile east of Blue Wing is the Big American Reduction Company's mine, which has been worked relatively to some depth. Three hundred yards southeast of this mine is the Luck Mine, 15 feet deep, and quite promising, with a vein of good width, though at this depth not highly charged with mineral matter. Two hundred yards still further southeast is the Silver Nugget Mine, 10 feet deep, the ores of which, it is thought, carry a considerably larger proportion of silver than most of the ores of this belt. A trench and pit on W. S. Holloway's farm also show a fair prospect. All of these, the Big America Mine excepted, are mere prospect holes, and must be dismissed without further notice, inasmuch as the work here is insufficient to allow of a prediction of future developments.

Big America Mine.—This mine, sometimes known as the Royster, is entered by two shafts, one 40 and the other 80 feet deep. They are but a few feet apart, and connected by a slope in the vein.

The following summary and notes of actual observations will bring out the necessary points, so far as the present work is concerned: The vein has a strike N. 15° E., and a dip eastward of 80° to 90°. Silicious schists run into quartz and *vice versa;* chloritic schists give place to bornite, and the reverse; in places the quartz is filled with bornite; malachite stains are abundant on all surfaces near the vein; occasionally very deep green chlorite appears in the midst of milk white quartz, and in seams in the vein. The vein is mostly quartz, and commonly leaves very clean walls.

In the North shaft the vein is two to four feet wide; in South shaft five feet. Several seams of bornite occur, sometimes separated by a horse of schist, more frequently by quartz seams or stringers. The quartz is much laminated, and gives blocks 2 to 9 inches thick. The average thickness of the ore seam is not far from nine inches; much of it as compact and pure as ore can be.

A large quantity of ore has been shipped from the mine, obtained exclusively in sinking the shaft and running the short drifts.*

The ore, with the exception of some malachite and azurite, and simple oxides of copper, is bornite. Iron pyrite and chalcopyrite are pres-

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* A level extends both to the north and south from the 80-foot shaft, but was not accessible at the time of my visit. I was assured that the vein was 4 to 5 feet wide, with large seams of ore aggregating 18 inches in width.—G. B. H.

ent in the merest specks. The ore is generally estimated to carry not far from 20 to 25 per cent. of metallic copper, a point which may easily be largely exceeded by a very slight cobbing. None of the assays accessible show more than about 5 ozs. of silver, with a trace of gold per ton.

There is a second vein 3 to 4 feet thick reported to lie 35 feet behind the vein above described. It is said to be of the same character and contents as in the first vein.

The Holloway Mine is a little more than $2\frac{1}{2}$ miles a little west of south from the Big America. Here are two veins, with indications of a third. They are on parallel lines, about 200 feet apart. The vein furthest west has been sunk upon only a few feet, and appears as a four-foot vein, with abundant stains of malachite and azurite, and "kidneys" of gray copper ore.*

The middle vein has been sunk upon 18 feet, and discloses an ore body two to four feet wide. The mineral contents consist of gray copper ore, with the accompanying oxides, so general in all these mines. This vein carries a larger proportion of ore and a smaller proportion of quartz than any other vein observed in the district (i. e., the vein is more largely made up of ore); all things considered, the start at this mine is unusually promising.

The surroundings of the mine, and the strike and dip, are substantially the same as those of the Big America, and its contents will not be materially different in the percentage of valuable constituents.

The Mastodon Mine (formerly the Pocahontas) is near the Granville-Person county line, as shown on plate XV. The only work done here is in one pit, to a depth of ten feet. The dip and course are as above; vein 3 to 4 feet, consisting of quartz, plentifully stained with carbonates.

The pit is near the edge of the property and some differences about the boundary line led to a discontinuance of work, pending a settlement. Considerable porphyritic material is seen here.

The Poole Mine is in Person county, about one-fourth mile nearly west of the Mastodon. The vein is very prominent and easily traced on the surface by the large outcrop of quartz. One shaft, 45 feet deep, and two shallow pits, constitute the developments.

This vein was 9 or 10 feet wide at the shaft, and showed the custo-

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* *Gray copper*, not in the sense of tetrahedrite, but because of its physical appearance, and approximation to chalcocite. The average copper contents will approximate (for the ore seams) 25 per cent.

mary signs of copper at the top, but at a very slight depth it "pinched out;"* and subsequent work failed to show further evidence of its presence in workable extent.

The Buckeye Mine, some few hundred yards west of the Poole, is similar in occurrence, and shows a disappearance of ore, and a pinching out of the quartz, quite similar to that at the latter mine.

Gillis Mine.—This mine, the earliest discovered deposit in this belt, is one mile south of the Buckeye, as seen on plate XV.

The mine was closed not long after Dr. Emmons' Report was prepared,† and as it has never since been worked, very little additional matter can now be given.

There are four or five veins on the mining tract of a little more than 360 acres, of which one is auriferous, and the others copper bearing. The vein which was worked, and which was described by Dr Emmons, coursed N. 10° E., and dipped eastward about 70°, but was not entirely uniform either in its strike or dip.

The South shaft was sunk 130 feet, and a level of 95 feet length, was driven from near its bottom, entirely in ore. The seam averaged nearly 11 inches; the mineral matter was vitreous copper, or chalcocite, and its derivations. The North shaft, one-third of a mile north of the South shaft, was sunk to a depth of 90 feet, the lower part being an underlay shaft in the vein. The vein is 3 to 6 feet wide, and pretty well mixed with ore, as in the South shaft, but not to so great an extent.

The refuse on the dump bears evidence to a large body of material of high grade, but of the condition of the levels, stopes and breasts, as relates to the ore supply, there is now no trustworthy evidence attainable; it is hardly probable, however, that the resources of the property are exhausted.

For the benefit of readers to whom Dr. Emmons' Report is not accessible, the following brief summary may be given.‡ He says: "The

* It is frequently the case in the lenticular vein formations in this State, that the lenticles taper down to a very narrow thread of vein matter, (and sometimes the veins disappear altogether); but this thread many times leads to another and similar large body. Through a very little inattention on the part of a careless or ignorant miner, this clew may be lost. Many cases of this "pinching out" have been subsequently proved to be incorrect on this precise ground, and the vein has been found again.—G. B. H.

† Geology of the Midland Counties of North Carolina, 1856, p. 344.

‡ The same, pp. 344, 345.

rock immediately investing the mine is the altered slate belonging to the Taconic system." He at first thought it to be talcose, but later regards it as argillaceous. "The veinstone is porous quartz, stained and impregnated with green carbonate of copper. In the North shaft, calc-spar has accompanied the quartz, though it is mostly in bunches. The vein carries in addition to the vitreous copper, silicate of copper, green carbonate, red and black oxides of copper, the latter rare; and the red oxide first appeared in the eighty-foot level, where the vitreous ore is in a continuous belt running across the shaft." Describing the lode, he states that "at the depth of eighty feet it is eighteen inches in the south shaft, and about five feet in the north."

Dr. C. T. Jackson, who made a study of this vein and surroundings, when it was worked, makes a few observations, which are worth repeating here:* "The strata are occasionally disrupted by dikes; about half a mile from the Gillis, and dipping westward to it, is a dike bearing N. 20° E." (the vein bears N. 10° to 15° east, and dips E.), "containing abundant sprigs and grains of disseminated native copper. Epidote occurs both in the trap rock and in the quartz, and in the slate strata near the dike, which seems to indicate that the trappean rock is of the same geological age as the quartz veins. The copper vein varies from 8 to 12 inches† in thickness, and the mineral part is from $10\frac{1}{2}$ to 11 inches, with a dip 70° to 75° eastward. The ore in the north shaft, 90 foot level, is pretty well mixed with the gangue; the vein is estimated to be about 2 miles long."

The Copper World Mine.—This mine is in Person county, one and a half miles, a little west of south from the Gillis, as shown on plate XV

The North shaft is reported to have a depth of 100 feet; but there is little evidence of vein matter here. The South shaft, one-fourth of a mile south of the above, was not accessible, when visited, as it had been allowed to fill up with water. The blocks of quartz indicate a vein of some size. The ore is the "gray ore" of the district (approximating to chalcocite), with red oxide and carbonate of copper. The blocks of ore are often 6 to 9 inches thick, and indicate a good seam of rich ore.

The Yancey Mine.—This mine is in Person county, one and one-half miles nearly south of the above. Here what is regarded as two veins

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* Private Report, 1857.

† Probably should have been 8 to 12 feet.—G. B. H.

have been cut, one of which is believed to be a feeder or cross-course to the other.

The "main vein" is traceable by its outcrop ½ mile, coursing N 15° to 20° E., and dipping eastward 75° to 80°. The vein is occasionally 14 feet wide; rarely less than 6; and the ore seam is wide and persistent. The ore—the "gray ore" of the region—is very abundant.

The "cross vein," or "feeder," appears one-half mile south of the "main vein." Here a considerable amount of work has been done.

This vein also is wide and persistent, and has been worked by "open cut" for a long distance, with an abundant ore supply.

The ground was covered with snow at the time the region was visited, and the relations of the veins could not be made out satisfactorily. The mineral in both veins is the common "gray ore," above described, with its usual modifications. Assays give:

"GRAY ORE," YANCEY MINE, PERSON COUNTY.

	(72)	(73)	(74)
Gold, per ton	1-10 oz.	1-10 oz.	1-10 oz.
Silver, per ton	6 7-10 "	5 4-10 "	1-2 "
Copper, per cent	48.17	26.16	31.14

The amount of work thus far done is not sufficient to justify more than a few general remarks and conclusions on this long neglected district.

Apparently the veins are "bedded veins," from the fact that their courses and dips conform to that of the country schists, and like most bedded veins in this section they are lenticular, and not always continuous either in length or in breadth, as the reader will have discovered from the description of two or three localities. Nevertheless, the numerous outcrops, and exposures in underground works, are on the whole favorable. As to continuity in depth it is yet too early to speak, for the underground works are too shallow to show what may be expected at depths considerably below the surface.

As to the continuity of the deposits, as distinguished from the veins, which is, of course, the important point, there is a still more perplexing question; for here, as elsewhere in the "slate formation," the shoots or lenticles of ore come in and go out (though the vein may preserve its regularity); but there are no indications that this takes place with greater frequency or abruptness in this region than in other

regions where the phenomenon creates no uneasiness or concern for the future.

The Yancey and the Gillis mines, and the Big America, in a lesser degree (for it has been only partly opened), show that there is a persistency through such linear extent, as will allow a good basis for calculation.

The promise of profit to capital in this district is large enough to justify careful development of these underground stores.

The ores, as a whole, have not been thoroughly examined with reference to their purity, but so far as examined, they are believed to be free from arsenic and antimony, which, if true, will make them very desirable for mixing ores in copper smelting. It may be added further that they will have a greater value still for the copper matte treatment of the auriferous ores of the section, whenever metallurgical operations are conducted on a steady scale ; a use for which their precious metal constituents will give some slight advantage over the treatment for copper simply.

Copper Ores of the Western Counties.

In the gneissoid belt, immediately to the west of the syenetic belt, only two mines are known which promise well for copper.

Burrell Wells Copper Vein.—In Gaston county, about two miles south of Tuckasege Ford, on the Catawba River, there have been located six parallel veins, of which the vein known as "No. 2" carries auriferous copper pyrite, but it has not been developed sufficiently to justify any conclusions of the amount of ore to be expected.

Graham Copper Vein.—In Lincoln county, on the farm of Maj. W. A. Graham, and about four miles northeast from Iron, a copper vein has been prospected by pits along nearly 100 feet of the outcrop. The vein is 30 to 42 inches thick, and appears very promising for the amount of work done. The ores contain some copper, and occasionally the material becomes a true copper ore. Assays range in gold from $18 to (occasionally) $35, and even to $89.74.

There are several copper mines in the western part of the State, which were not mentioned by Emmons, although opened before the war. The chief of these are in the ranges, one in Jackson and Haywood counties, the other in Ashe and Alleghany. Those of the former were visited shortly after the war, when little was to be seen.

The copper belt of Jackson and Haywood occupies the middle portion of Jackson county, from the head-waters of Tuckasege River northward to Scott's Creek and Savannah Creek, a region which is characterized, geologically, by the prevalence of hornblende schists, gneisses and syenites. The principal points where mining operations have been carried on are the Waryhut*, Cullowhee, and Savannah mines, although work has been done and symptoms of the presence of copper discovered at many other places, as Shell Ridge, Scott's Creek, Sugarloaf, Panther Knob, Wolf Creek, etc.

The Waryhut, the first-named of the above mines, had been opened by a shaft said to have been 100 feet deep. The mine is on Waryhut Creek, about six miles southeast of Webster. The vein was described as from five to eight feet thick. The ore is copper pyrites, with the usual carbonates and silicates near the surface. The rock is a tough, grayish, syenitic gneiss.

The Cullowhee Mine is on the Cullowhee Mountain, southeast of the former, and at an elevation of several hundred feet above it. The rock is a gray gneiss, with hornblende in immediate association with the vein. The thickness of the latter is estimated to be about eight feet. The ore is copper pyrite, but too much weathered to allow an estimate of its richness. The vein was not well exposed when visited, and so no minute examination could be made. A like remark may be made in regard to the

Savannah Mine, which is nine miles southwest of Webster, on Savannah Creek. The rock here is a massive, coarse, garnetiferous syenite, and the vein about nine feet thick. The ore is copper pyrite, but no fresh surfaces were exposed when the mine was visited, and therefore no good specimens could be procured for analysis.

My impression of the Cullowhee and Savannah Mines was that they are very promising, and well worthy the attention of capitalists. Of the Waryhut I could form no opinion, because it was not accessible.

There is a copper mine in the northern part of Haywood county, near Wilkins Creek, where two shafts have been sunk and a drift of 76 feet cut, but the vein was not accessible when visited. There was, however, a very formidable outcrop of *gossan*, indicating a large vein. For further information of this mine, as well as of others belonging to this

* Sometimes written and pronounced, "Way-ye-hutta;" also, "Waychutta."
G. B. H.

range, reference may be made to the following notes, by Mr. C. D. Smith*:

"There is a favorable outcropping of copper near the head of Big Ivey Creek, not far from the Madison and Buncombe county line, which presented a favorable appearance. There is another point only a few miles from Asheville, where there is an outcrop deserving of exploration for copper. The belt passes into Haywood county, at the head of North Hominy, where there is an outcrop in every way flattering for copper. The gossan is of excellent quality, the vein at the surface large, and the walling favorable for a copper mine.

"The zone passes thence down North Hominy to Hall's mill, with several attractive outcrops between George Hall's and the mill. Eight or ten miles northwestward there are favorable outcrops again in the Massey Cove, and on Little Mountain, in the direction of Waynesville.

"After passing Waynesville the copper belt widens out, the zone we have been following, passing into Jackson county at the head of Scott's Creek.

"There are several points between this and the Waryhut Mine. Some of these localities have been tested by Messrs. Oram & Davis, who are the owners of 16,000 acres of land embracing these outcrops. I have been informed that the veins are of good size, and the ore (chalcopyrite) of excellent quality.

"The range or zone from the head of Scott's Creek passes along the range of the Double-top Mountain, showing the outcrops already alluded to.

"In 1860, the Waryhut Mine showed handsome specimens of malachite, chalcopyrite, and occasionally some native copper. Shell Ridge, Buck Knob and Hornbuckle may all be included in this belt.

"The old Savannah Mine is northwest of the Shell Ridge. Here the first discovery of copper in Jackson was made. At this mine is a vein of good yellow copper. This property is on a transverse section of rocks; the gneiss and syenite strike off to the northwest. The new Savannah Mine is about half a mile from the old Savannah Mine. At the depth of 25 or 30 feet is a mixture of gossan, black copper, yellow copper, etc. The vein is apparently 8 to 12 feet thick. The outcrop continues one-fourth mile northwest, and also southeastward. This zone passes northwestward crossing the county line in Bet's Gap, and shows copper on the corner rocks at the head of Cowee Creek in Macon county.

"The Buck Knob zone outcrops as a broad belt in Macon county, at the Corbin Knob, where some copper has recently been obtained. On Tessentee and Middle creeks, in the southern part of Macon, there is a large outcrop of gossan. A large vein appears on Middle Creek, near Cabe's mill, and the outcrop can be traced for one and one-half miles.

"A vein several feet thick appears in syenite rock, on the Patton property, near the Cartoogajay Creek, Macon county, 4 miles southwest of Franklin. Another copper property (the Waldrope property), occurs southwest from the above, at the base of the Nantegalee mountain. The copper belt crosses the Nantegalee mountain and passes into the southeast corner of Clay county. The zone shows on the west of the mountains, in Towns county, Georgia, where there are valuable copper prop-

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*Condensed from the Essay on the Geology of Western North Carolina, by Rev. C. D. Smith: Appendix D, p. 112, in Kerr's Geology of North Carolina, 1875.

erties. A noteworthy fact which I have learned, is that the ores on this entire zone in North Carolina, are remarkably free from arsenical impurities.

"Another copper bearing zone occurs on the head waters of South Richland Creek. Some work had been done on the top of the Caney Fork Bald, a mountain dividing the waters of Pigeon and Tuckasegee rivers, where a large quartz vein was cut, showing handsome copper ore. Along the spurs of the mountain, on the Pigeon or Richland side, I saw two fine gossan outcrops. Southwestward from this point, on the waters of Caney Fork, there are large exposures of gossan in Gunstocker Cove. The zone passes down Caney Fork, and crossing the Tuckasegee River, runs into Cullowhee Mountain, in which the Cullowhee Mine is situated. My recollection is that the vein is about six feet in thickness. It contains a rich yellow copper ore.

"From the Wolf Creek Mine, southwest of the above, this range passes southwestward into Macon county, on the waters of Ellajay and Buck creeks.

"There is another locality in Haywood county, in an entirely different formation. It is on Wilkins' Creek, 25 miles from Waynesville, down the Pigeon River. It is lithologically identical with Ducktown, and in the same geological horizon. A shaft was sunk, and a tunnel driven, which penetrated the vein for 12 or 15 feet, without reaching the opposite wall. The vein is almost solid arsenical pyrite, precisely such as the veins at Ducktown carry. I was assured that the outcrops of gossan extend for four miles northeastward, and generally continued as prominent as at the locality under consideration."

Elk Knob Copper Ores.—Of the copper range in Ashe and Alleghany counties, one of the most notable localities is Elk Knob and its spurs, within a radius of three or four miles. The prevalent and characteristic rock of this mountain and region is a garnetiferous hornblende schist with gray gneiss.

The Elk Knob Mine is on the northwest slope of the mountain, at an elevation of some 4,000 feet above the sea. The vein, which cropped out in a deep ravine, was insufficiently exposed, but it is evidently not less than six or seven feet thick. The rock is a dark gray gneiss.

The ore at the surface was mostly iron pyrite, with a moderate admixture of copper pyrite.*

The Miller Mine, at the southern base of the mountain, had been opened at the time this region was examined, and a shaft sunk to a depth of 60 feet; but nothing can be stated as to the character or size of the vein.

At other points on the slope of the mountain are promising outcrops of gossan, but there is no information at hand concerning the character and extent of the deposits.

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* At the time of my visit, in 1874, much of the copper pyrite was in layers to itself and tolerably pure. The above statement refers to the short adit, which was all that could have been seen by the author.—G. B. H.

Copper Knob Mine.—This mine, formerly known as the Gap Creek, is in the southeast part of Ashe county, about three miles west of the summit of the Blue Ridge, and $1\frac{1}{2}$ miles east of New River. It is accessible by well-graded wagon roads. It may with propriety be described as one of a series of veins in a mineral district.

One mile west-northwest is a series of veins, of which only two, on Rich Knob, have been investigated—they but slightly. One of these veins is ten inches wide. It carries ores like those of Copper Knob, and is regarded as promising as the Copper Knob vein at the same depth. Thirty yards northwest of this large quartz rocks, well-charged with schorl, lie on the surface, which carry gold in red oxides of copper and iron.

Another vein of schorl, with an admixture of oxides, which was cut on this Copper Knob tract, yielded $3.75 per ton of gold.

The Copper Knob tract contains 190 acres. There are three veins on this tract—one heavy quartz vein unexplored, a second vein which has proved to be barren, as far as examined, and a third vein well mineralized. This latter vein is in a large body of hornblende schist, though the prevalent rock of the section is a gray gneiss, with a strike N. 60° E., and a dip S. E. 40°. It is a true fissure vein, with a strike N. 35° W. and a dip N. E. 45°, but neither dip nor strike is uniform.

The vein in the upper part was accompanied by a selvage of peroxide of iron, extraordinarily rich in gold, the vein itself being quartz. The mineral seam occupied the centre of this quartz, and varied from 4 to 6 inches in thickness. In the 60-foot level the vein varies in width from 14 inches to 3 feet. On the northwest course, along this level, the vein contains the copper ores for 53 feet, when the quartz becomes slightly changed, and carries native gold, with brown oxide of iron, for about 36 feet. Here the bearing is changed to N. 43° W. The vein appears to be more mineralized on the northwest than on the southeast side of the workings, which run into the Knob.

The ore is unique: vitreous copper ore, malachite, chrysocolla, a very little chalcopyrite, brown ore, etc. Iron pyrite is almost wanting. The ore seam increased somewhat in width as greater depth was gained.

The shaft was sunk to a depth of 60 feet with satisfactory results, and subsequently deepened to (as reported) 140 feet. At this stage the mine became the prey of a company of speculators, and was tossed about as a foot ball, on the floors of stock exchanges, and it suited the management to conceal the real character of the lower levels. But the

concurrent testimony of many persons cognizant of the last work is that the resources of the mine continue good.*

The nature of the ore is shown in the following assays:

ORES FROM COPPER KNOB, ASHE COUNTY.

	(74 a)	(74 b)	(74 c)	(74 d)
Gold, per ton	1 683-1000 oz.	417-1000 oz.	2 775-1000 oz.	3 75-100 oz.
Silver, per ton	19 72-100 "	1 75-100 "	11 235-1000 "	35 33-100 "
Copper, per cent	...	...	23.825	37.44

Ore Knob Copper Mine.—The most remarkable vein in the State is at Ore Knob in the southeast corner of Ashe county. It is near the top of the Blue Ridge, and about 2 miles from New River. The mine was opened before the war, but not explored to any depth or with any system, and its real character was not developed until a much later period. The vein was finally opened by a series of shafts and tunnels, which uncovered a body of ore rarely equalled.

The accompanying plate (XVI) will show something of the topography of the region about the mine and a cross section of the vein. The topographical sketch was made from observations taken with a Locke's level and pocket barometer and compass.

The rock of the region is a gray (and usually) thin bedded gneiss, with mica schists. These have a prevalent strike a little east of northeast, and dip east at a tolerably high angle; though both strike and dip are subject to considerable variation. The walls of the copper vein are micaceous gneiss and mica schist, with a strike N. 57° E., and dip southeast at an angle of 40° to 45°. The copper vein is coincident in strike with the rocks, but is vertical, cutting across the strata

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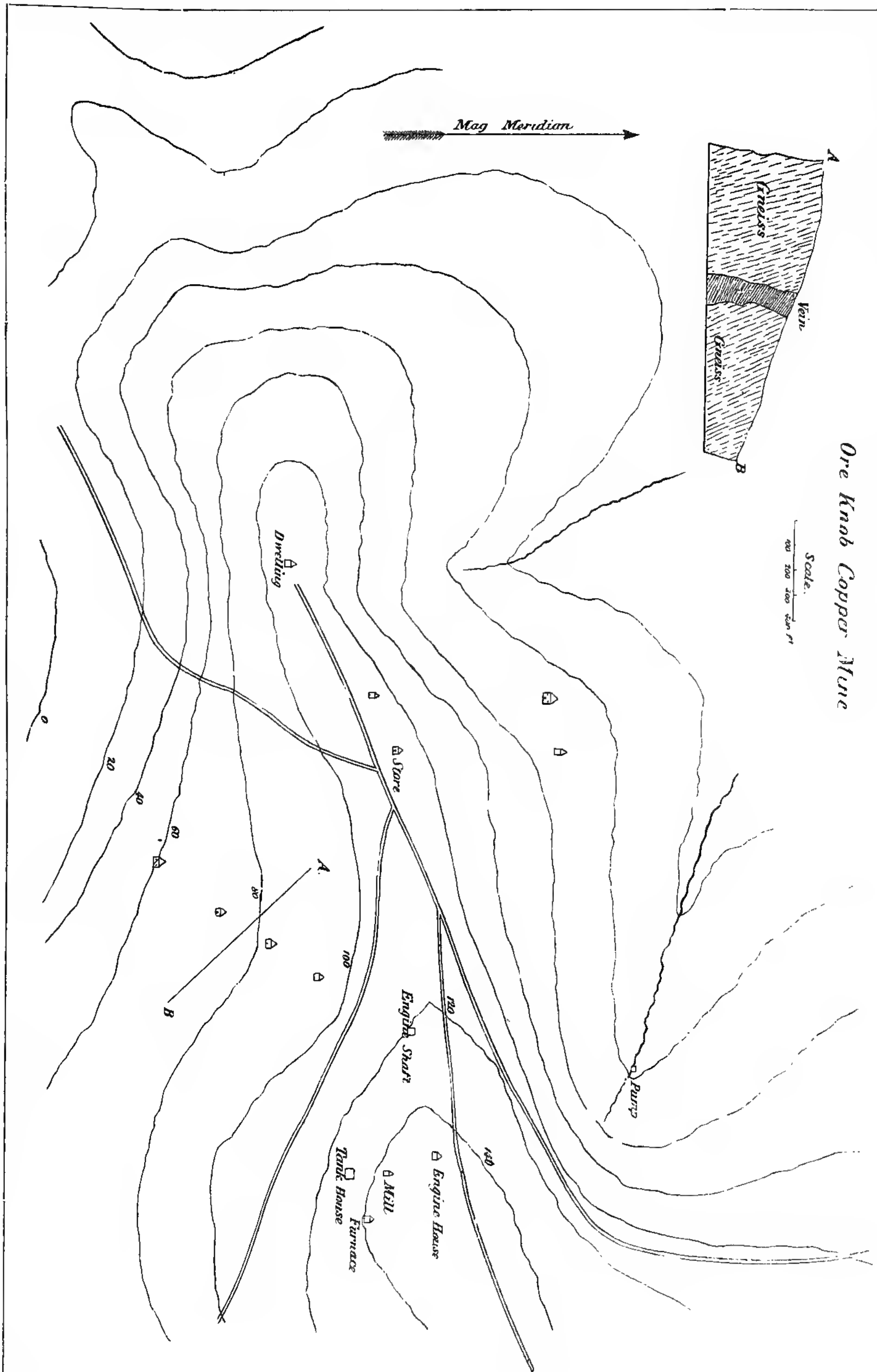
* Many of these observations were furnished by Hon. C. J. Cowles, of Wilkesboro. The following concerning the Copper Knob deposit may also be added from Dr. Emmons' notes: "It appears to occupy a vein fissure, formed prior to the time when it became filled with mineral, and therefore it seems highly probable to become a permanent vein. The rock is a hornblende slate, which appears to have been altered; it is only ¼ mile wide, and seems to be intruded in the talco-micaceous schists, and, if so, it furnishes a favorable indication of a valuable mine on this ground alone—April 26, 1858."—G. B. H.


Ore Knob Copper Mine
Scale.
Mag Meridian
Gneiss
Vein
Gneiss
A
B
Dwelling
Store
Engine Shaft
Pump
Tank House
Mill
Furnace
Engine House
A.
B
0
20
40
60
80
100
120
140

in dip; so that it is a true fissure vein, and not bedded, like those at Ducktown.*

It is traceable by an outcrop of gossan for more than a mile, and has been proved by trial shafts and trenches for nearly 2,000 feet.† The breadth of the lode varies from about 6 to 15 feet (in some cases 20‡), averaging about 10, probably. Eleven shafts have been sunk vertically in the vein; the deepest is 400 feet, and several others are down 200 to 300 feet.

As the walls are so nearly vertical it was not necessary to leave many pillars; and not much timbering was needed in working the mine. There is, properly speaking, no gangue stone, the whole breadth of the fissure being filled with ore.

The gossan, which is decomposed oxidized ore, extends to an average depth of over 50 feet in the different shafts, the lower half containing a valuable percentage of copper in the form of malachite and oxides. Below this level of oxidation, the ore is the unaltered sulphuret.§ Some parts of the vein contain magnetite, quartz and garnets. The rock is hard, but there is no difficulty in winning the ore.

The richness of the lower part of the gossan and upper part of the pyrites will be seen by quotations from a report on the mine by Dr. T. Sterry Hunt, who examined the mine in 1873:

"Two samples of the gossan taken at distances of two or three feet above the sulphurets, yielded respectively 14 and 22 per cent. of copper."

Of the unaltered portion he says:

"Some parts of the vein are filled with copper pyrites, mixed with more or less

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*Prof. Thomas Egleston, of the School of Mines, New York City, has kindly allowed the use of his valuable notes of observation on this mine; especially from his paper read before the Staunton meeting of the American Institute of Mining Engineers, May, 1881, and published in the Transactions for that year. They will be found to add materially to a knowledge of this mine.

† Egleston, in his paper before the Am. Inst. of Mining Engineers, May, 1881, says that one wall of the vein is always sharply defined; the other is in the rock; and the ore dies out in it. Its penetration is very nearly constant, but there is no seam to give a sharp line of separation.

‡ In 1874, I saw a width of vein (for a short distance) of 21 feet.—G. B. H.

§ Egleston, paper before quoted, says the ore consists of pyrrhotite mixed with chalcopyrite and quartz in variable proportions. Hardly any other minerals except a small amount of carbonate of lime, some little black mica, and occasionally garnet, can be seen in the rocks.

magnetite, and yielding in different specimens 17 to 22 per cent. of copper, while a larger portion consists chiefly of an impure variegated ore, giving in different assays 35, 39 and 45 per cent. of copper......An average sample of fresh and undried ore from a large pile gave 25 per cent., and another from a large pile, chiefly of iron-black ore, gave 36 per cent. of copper."

The average of the ores undergoing reduction, in August, 1874, was estimated by Mr. Clayton to range between 12 and 20 per cent.

The gold in the ore is reputed to be present in traces only.

A few notes from the paper of Prof. Egleston alluded to (page 227) will show the condition of the later working of the mine:

"The mine was originally opened on a very rich streak of chalcosite running at times as high as 30 per cent. in copper. The works, which were constructed to treat it, were designed for the Hunt and Douglass' process,....which was worked on a large scale till the amount of carbonate of lime, which came into the ores, rendered it impossible to be used any longer....the present smelting works were then built. The ores afterwards became poor, and no traces of chalcosite are now seen in the mine.

"After a series of experiments extending over many months, it has been found that at present prices an ore containing 3 per cent. of copper just pays the expenses of mining and smelting.

"Analyses Nos. 1 (75) and 2 (76) show the mineralogical composition of the ore taken from each of the two (2) shafts of the mine. No. 3 (77) is a sample taken from the heaps of poor ore lying on the surface:

ANALYSES OF ORE, ORE KNOB COPPER MINE, ASHE COUNTY.

	(75)	(76)	(77)
Chalcopyrite	11.33	13.30	4.76
Pyrrhotite	37.46	35.74	48.78
Sesquioxide of iron	8.14	16.34	18.36
Alumina	1.84	1.49	....
Manganese	0.16	.50	.76
Lime	5.32	7.84	7.21
Magnesia	.35	.94	.30
Carbonic acid	4.76	7.19	6.00
Zinc	.67	.66	.65
Cobalt	.09	.09	.095
Nickel	.71	.92	1.08
Silicious residue	29.10	13.57	12.80
	99.93	98.58	100.79
Metallic copper	3.92	4.60	1.65

Alkalies not determined.

"The analysis shows the ores to be of exceptional purity; no trace of arsenic or antimony could be found in any of the samples.

"About fifty per cent. of the ore mined is sent to the smelting work.

"The ore might be enriched much further by careful hand-picking. No dressing in the ordinary sense of the word is applicable to it, since the pyrrhotite and chalco-

pyrite are of very nearly the same specific gravity. No effort is made at dressing, except with the "fines," and the only attempt then made is to get rid, in a rough way, of a part of the quartz in the ore.*

"The plant is capable of producing a much larger amount of copper than it now does. The ore is so exceedingly pure, and the fuel (charcoal) so entirely free from everything deleterious, that with careful refining a very high grade of copper might be made.

"Pig copper is arrived at in four and ingot in five operations. The process consists of:

1. Roasting the picked ores and the dressed fines in piles.
2. Fusion in a shaft furnace for mattes, generally called single mattes.
3. Roasting the mattes (Nos. 2 and 4) in piles.
4. Fusion in a shaft furnace for black or pig copper, and concentrated or double mattes.
5. Treatment of the salamanders.
6. Fining and refining."

The details of the work call for no special mention.

The cost of labor, fuel and most supplies, was very low.

An interesting series of tables was also prepared by Prof. Egleston, from which the following are taken; they refer to a period of several months during the later work of the establishment:

"SUMMARY, COST OF SMELTING PER TON.†

Roasting the ore, labor and fuel	$ 0.18 14-100
Smelting roasted ore, labor and fuel	3.32
Roasting single and double mattes, labor and fuel	1.
Smelting roasted mattes, fuel and labor	3.24
Refining pig copper: as each ton of the ore yielded 105 lbs. fine copper, the cost per ton of ore would be	.16 1-4
Superintendence and other expenses, as itemized, per ton	.31
Repairs and materials, tools, etc	.33 1-2

"The cost of copper per pound from January, 1879, to April, 1880, was (including all charges for freight, etc.) 12 1-2 cents; but from this should be deducted the profits of the company's store, which reduced the net cost to 10 39-100 cents per pound. The total copper shipped during this period was 1640 375-1000 tons of 2000 pounds.

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* Still later, in the last days of working the mine (1882), the contents of the ore in copper had fallen somewhat lower, and a more careful sorting was practiced, which brought up the copper in the part smelted to about 5 per cent.—G. B. H.

†The Superintendent, Jas. E. Clayton, informed me in October, 1882, that the cost of raising the ore during the preceding three years was between 65 and 66 cents per ton. He also added that the cost of producing the copper per pound had slightly increased after 1880.—G. B. H.

"In order to see how the copper compares with other coppers, ingots from Lake Superior and Baltimore were analyzed and tested. The analyses are given below:

COMPARATIVE ANALYSES OF INGOT COPPER.

	(78) ORE KNOB.	(79) LAKE SUPERIOR.	(80) BALTIMORE.
Metallic copper	99.80	99.83	99.65
Oxygen	.39	.15	none.
Sulphur	none.	none.	none.
Silver	.05	.026	.066
Lead	.01	.016	.044
Arsenic	none.	none.	none.
Antimony	none.	none.	.035
	100.25	100.022	99.883
Ounces of silver in ton of 2,000 pounds of copper	14.6	7.3	19.75

"It will thus be seen that the amount of oxide of copper in the ingot analyzed was 0.93 per cent., an amount which, although very small, is sufficient to make considerable difference in its value in the arts. The reputation of Lake Superior Copper is chiefly owing to the very small quantities of oxide of copper which it contains.

"The tensile of strength of Ore Knob Copper was found to be 30,660 pounds, and that of Lake Copper, 30,790 pounds to the square inch. The difference is altogether insignificant. The Ore Knob Copper, though varying in quality, is equal to the best grades."

As the establishment has been closed some four or five years, it is not necessary to pursue the subject further, though there is sufficient material to interest the public. It is believed that the facts given will present a sufficiently clear picture of a great North Carolina industry to the general reader, and at the same time all the important data bearing on the geology, which would be of value to the specialist.

It is proper to add that the Messrs. Clayton pursued the work with remarkable energy, and the highest scientific and financial ability; and the influence they exerted on the prosperity of the community about Ore Knob will long be manifest.

Peach Bottom (or Maxwell) Mine.—This mine is situated in the western part of Alleghany county, on Elk Creek, near New River. The vein is in a soft decomposable gneiss; with the hanging wall of a dark compact hornblende. It has a strike N. 54° E., and a southerly dip of about 80°.

The ore consists almost entirely of chalcopyrite, accompanied by a trace of galenite; iron pyrite is almost wanting. It is disseminated in the gangue, but is susceptible of easy dressing—the method formerly adopted in preparing it for market.

Two shafts have been sunk, several hundred yards apart; the East shaft 140 feet, and the West shaft 80 feet in depth; and in both the mineral deposit was struck. The vein widened in descent from 4 feet 4 inches in the 80-foot level, to 6 feet in the 140-foot level.

It is reported that the argentiferous lead vein, alluded to on p. 204, accompanies this copper vein, lying behind it on the north wall, and with a thickness of 6 to 9 inches.

There are indications of the existence of copper ore deposits at several other localities of this region:

In the northern extension of the Ore Knob deposit; and in Wilkes county.

In Surry county, on Moseley's farm, 5 miles from Elkin, a yellow copper ore is found in a heavy quartz vein, which is said to be 3 feet wide. The country schists adjacent are sprinkled with pyrite.

Near Trap Hill, in Wilkes county, fifteen miles from Elkin, is another locality. On the east side of Bryan's Knob is a bold quartz outcrop traceable for nearly 4 miles. It is sprinkled everywhere with pyrrhotite and pyrite, with a small percentage of chalcopyrite—frequently auriferous. Occasionally large masses of these are found. Thus far, insufficient work has been done to determine the resources of this vein. This vein is accompanied by another vein a few rods westward.

The endeavor has been made in the preceding pages to make as full an exhibit as possible of the present resources of the State in this important metal; and at the same time also to indicate, as far as our knowledge goes, the possibilities of the future. The last aim is necessarily imperfectly attained; but this at least has been measurably accomplished: to point out where such deposits may be found, and to give all attainable data for an intelligent investigation by such persons as may desire to look into the subject from a business standpoint.

The amount of copper produced in North Carolina at the present time is small. The more favorable conditions of the copper industry in the Lake Superior region, and in other mining districts in the West, have forced the market price of copper to so low a point, that successful competition on the part of the North Carolina mines is a matter of doubt.

It will be evident that the present price of copper offers little encouragement for an exploitation of such deposits for copper alone—the abandonment of Ore Knob sufficiently shows this; nevertheless if this establishment had been in possession of railroad facilities, (in tead of

being compelled to haul the ore 45 miles over mountain roads), the result might have been otherwise.

The present disposition to extend the railroad system into the mountainous section of the State, will not unlikely materially change the entire aspect of the case, and relieve industrial enterprises from the disabilities they now labor under.

There is, however, another side to this subject, viz.: the importance of such stores as a necessary, or at least, important means of developing the metallurgical treatment of our auriferous ores satisfactorily, in which the disadvantages are not so evident; rather there are some certain advantages to be expected, which will add a little to the receipts of the miner, viz.: a return for the gold contents of such ores. This may not be large, as our copper ores are not highly auriferous or argentiferous, but it may be sufficient to turn the balance favorably.

The matter of bringing these deposits to the surface, and thence to the markets, is primarily one of business, viz.: a safe investment with a low capitalization, prudent management, good railroad facilities, and a market with sufficiently varied interests to induce a lively competition.

The fact that these conditions are only imperfectly met now, is a defect inseparable from the crude beginnings of an industrial system, and is not attributable to a lack of nature's subterranean gifts.

SECTION 4. GOLD.

The influences which have retarded mining operations in other directions account also for the fact that but few of the gold mines of the State are now in operation. Some of the more noted mines, however, have claimed the attention of capitalists, and work is now prosecuted at those places with more or less vigor.

The total amount of the precious metals produced by the mines of North Carolina up to Dec. 31, 1886, so far as U. S. official records afford evidence, is as follows:

Gold	$11,089,502 36
Silver	84,019 75
Total	$11,173,522 11

It is certain, however, that this is but a part of the production, for much of it is known to have been exported directly by companies having headquarters abroad. Moreover, up to the time of the discovery of gold in California, there was a large demand for native gold by jewelers, and the Carolina gold was in request on account of its beauty. It is not an unreasonable conjecture that the amount which has in various ways escaped official notice is as large as that on record; and that the total amount produced in the State can hardly have been less than $22,000,000.00.

At the psesent writing the following mines are at work: Portis, in Nash county; the Cagle, Burns and Bell, Moore county; the Steel, Coggins and Russell, in Montgomery county; the Crowell, in Stanly county; the Uwharrie and Hoover Hill, in Randolph county; Gold Hill and Icenhour, in Rowan county; the Phœnix, Rocky River and Reed, in Cabarrus county; the Henderson, Rudisill, St. Catherine, Point, Davidson, Cathey, Hill, Dunn and Ray, in Mecklenburg county; the Howie, Hemby and Stearns, in Union county; the Catawba, in Gaston county; the Vein Mountain and Marion Bullion (Granville), in McDowell county; the Hancock, Mills, Carolina Queen, in Burke county; the Boilston, in Henderson county; the Double Branch, in Polk county—in all 35.

At what time gold mining was first undertaken in this section can-

not now be ascertained, but several traditions, which carry a large probability of truth, would seem to indicate that a strong suspicion of the auriferous character of the section was entertained before the Revolutionary War. One of the localities in this State, which it is believed was worked before that struggle began, was the Oliver Mine in Gaston county. The Brewer Mine in Chesterfield county (South Carolina) is another; and the "Aborigines' Shaft," at this latter place, is still pointed out, where work was done earlier than any known records.

The first authentic find was on the Reed plantation, in Cabarrus county, where a nugget was found in 1799. Its value was not suspected at first, but when it was ascertained to be gold, a systematic search was undertaken, and a large number of nuggets were unearthed.*

Success at this mine stimulated search elsewhere, and by 1825 gold mining on a vigorous scale was carried on along the entire Appalachian slope, from Virginia to Alabama. The placers or like deposits were first worked, then the gossan outcrops of the veins, where slight skill and few and cheap appliances were adequate to the work. The exhaustion of these easily worked stores was effected just at the time of the discovery of gold in California, and there was a large exodus of miners to that territory. The mining work had not recovered from the retarding influences of this exodus when the civil war came and put an end to all work. At the close of the war but one gold mine in North Carolina was in operation.

The difficulties attending deep mining, and the still greater difficulty of extracting the gold from the sulphuret ores, have been only partly overcome at the present time—a matter which will be presented more fully at the end of the section.

With the exception of minute quantities of telluride of gold at the King's Mountain Mine, and possibly at a few others, gold is believed to exist in the metallic state, and is generally, if not always, alloyed with silver.

* Emmons' Geology of the Midland Counties of North Carolina, 1856, p. 166.

Fineness of Native Gold in North Carolina.—The fineness of native gold varies throughout the State, and to a large extent with the different formations in which it occurs.

The easternmost belt shows a variable fineness at the different points. Thus, toward the northern part of the State, well up to the Virginia line, assays show the gold to be about 925 m. fine, with from 60 to 75 m. silver, and a *very* little iron, and occasionally a trace of copper; at the Portis Mine in Warren county, for example, very rarely does the fineness reach to 950 m. Further south, in Moore county, the

"It occurs in the foliations of the slate,* and to a less extent in the joints, or with and through associated ores, such as quartz, galenite, blende, etc., in so fine a state as to be invisible to the naked eye.

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range in fineness is from 700 to 750 (rarely 850) gold, and 225 to 300 silver, with similar base constituents. In the first mentioned locality, the gold is almost strictly "placer"; in the latter it is partly derived from a mill treatment of the schists.

Throughout this entire area, arsenic, antimony, etc., are rare in the native gold, and it is not quite certain that these metals may not have been introduced by careless manipulation.

In the central syenitic and granitic region, gold ranges from 800 to 950 (*very* rarely 975). Thus, for example, at the North State, Phœnix, Reed, Capps and Rudisil mines, 900 to 925 would characterize the average, with a trifle more iron, and sometimes with as much as 5 to 10 of copper—for the gold comes from veins, which carry large bodies of pyrites.

In the Huronian region, just to the east of this syenite belt, the gold is derived from schists, which often carry pyrites or galenites, and these, especially the galenites, have apparently had a large influence in lowering the grade, which rarely rises to 900; examples of this may be seen at the Howie, where the fineness of the gold varies from 725 to 775; at Gold Hill, from 850 to 900; at the Phifer, from 750 to 800; and most frequently the fineness will not rise above 825. Where galenite is abundant, the proportion of gold is reduced to 450, and on rare occasions to a still lower point, as, for example, at the Davis Mine, we find gold as low as 450, and sometimes less; at the Stewart, gold 550, silver 447. The native gold itself does not often contain more than a trace of lead.

In the extreme western part of the State, the gold is almost wholly placer gold, and occurs more or less in nuggets. The fineness is rarely as low as 800, and most generally runs above 900—occasionally rising to 980—with the least possible amount of base metal.

In the Burke county mines, which are chiefly placer, the gold is tolerably uniform, from 825 to 850, as may be observed at the J. C. Mills mines, the Hancock Mine, and the Brindletown localities generally.

In the adjacent county, McDowell, where the gold is mostly placer, the grade lessens to 780 or 800; as at the Vein Mountain Mine. In Rutherford county, still further south in this belt, the grade rises to nearly 900.

In Polk county, still further south in this same belt, the fineness again rises, being rarely less than 900, and often more than 950; as may be observed at the Double Branch, and the Splaun mines.

When it is said that iron is found in native gold, the statement must not pass without some qualification, for in some cases it is known to be due to a slight proportion of oxide of iron, mechanically contained in the minute cells, in the nuggets or grains. And the same has also been occasionally observed of oxide of copper, See further the *Engineering and Mining Journal*, Sept. 18, 1886.—G. B. H.

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* F. A. Genth, in the Geology of North Carolina, by W. C. Kerr, 1875, p. 283. His remarks there are here reproduced, with some condensation.—G. B. H.

"It has been observed in four different geological positions:

1st, It is met with in the *mass* of the gneissoid, granitic and hornblendic rock.

2d, In quartz veins, often associated with iron pyrite, chalcopyrite, galenite, and other minerals.

3d, In ore beds cotemporary with the strata of the rock, in which they are found, as in chlorite and talcose schists, argillites, quartzites, etc.

4th, Loosely in the soil and decomposed rock, especially in gravel deposits, resulting from the destruction of the above first three formations."*

"Many of these quartz veins are in reality beds, as they coincide in strike and dip with the stratification, whilst an equally great number run in every conceivable direction, and dip just as irregularly. The greater part of these quartz veins contain no gold, or so little that they could not be profitably worked. This is especially true of the larger veins of milky and vitreous quartz.

"In many cases the small veins—principally those which contain granular and saccharoidal quartz—are rich in gold. Some of the large veins, especially those containing much cellular quartz, have frequently been found to be the most productive. These cellular spaces in the quartz result from the decomposition of pyrites, which once occupied

* This summary is substantially the same as that given by Emmons in his Report, (Geology of the Midland Counties of North Carolina, 1856, p. 128,) and is comprehensive enough for the purposes of this report, but should both be enlarged and subdivided to be scientifically accurate.

Examples of the first class are in the central syenitic area, and to a less extent in the gneissoid area immediately to the west of it.

The quartz veins of the second class in their most characteristic forms are found for the greater part in this central syenitic area, and in the gneissoid formation near by, to the west, and in the Huronian belt to the east; but in this latter area, quartz veins are by no means confined to any formation, and it should be mentioned that if the irregular quartz seams, so common to every formation in the entire region, are to be included under quartz veins, they will be found at every mine.

The ore beds of the third class most abound in the entire Huronian formation, and to a less extent in the gneissoid region. (See Appendix B, at the end of this section.)

The placers and gravel deposits of the fourth class were originally found over the entire auriferous parts of the Appalachian slope, but have been exhausted at some of these points. In the Portis Mine district they are still abundant, though relatively poor; in Randolph and Montgomery counties they are extensive, but not easily accessible; they are very abundant in the Burke, McDowell and Rutherford region; and abound to a large and indefinite extent in the western and mountainous parts of the State. (See Appendix A, at the end of this section.)—G. B. H.

the now empty spaces, leaving them occasionally quite free from oxide of iron, but more generally rusty, and, in some cases, more or less filled with limonite.

"At a greater depth, where the pyrite is not decomposed, the gold is so much mixed with heavy sulphurets that it cannot be extracted with profit by the method now followed. In other cases the gold entirely disappears.

"Most of the gold veins in North Carolina were abandoned where the iron and copper pyrites had increased so largely as to make the milling of the ore difficult."*

"The gold in these mines is not very evenly distributed through the mass, and the veins often contain portions relatively poor, alternating with portions rich in ores—which latter are called shoots or chimneys. Such shoots are really veins inside of a vein, and frequently quite regular in their dip.†

"The gold deposits, which are contemporary with the slates, are sometimes of greater importance than the true gold veins. Their width varies from a few inches to 70 feet.‡

"The gold in them is often found without any mineral admixture, and the auriferous schists or "slates," show no line of demarcation,

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* The present condition of the mines is substantially as follows: The gossans of the mines (or "brown ores") were generally worked out as far as possible and as long as they continued profitable. At the permanent water line (40 to 60 feet), these brown ores began to give place to the unaltered sulphurets, though at the depth of 300 feet the sulphurets are not entirely free from those influences, which alter and peroxidize them. In almost all the mines the brown ores have been exhausted, excepting a few pillars or overlooked bodies. And in a very few mines, which peculiar circumstances held back and reserved from mining work, the low grade gossans still exist either in part or as a whole.

In short, the ores of the future are the deep lying sulphuret ores, which require well-planned and expensive machinery for successful extraction, and the most economical, and careful, and (to some extent) complex methods of treatment. These points will be elaborated in the conclusion to this section.—G. B. H.

† See plates of the Gold Hill, St. Catherine, McGinn and Rudisil mines.

‡ It may be said that sometimes they are hundreds of feet wide, for example, the ore belt at the Howie (or Cureton) Mine, or at the Burns Mine, in Moore county; but only a comparatively small part of such a body can be profitably treated; thus the distinction between the "vein," so-called, and the "country," is a practical, not a geological one. There is frequently no marked lithological or mineralogical difference between the productive and the unproductive part, but it is also the case sometimes, that secondary agencies have been at work altering the narrower (though still very wide) belt, and enriching it, as appears to be the case at the Jones Mine, Randolph county. (See Appendix B.)—G. B. H.

and cannot be distinguished from the barren layers; but generally, and subsequently to its deposition, it has been acted on by chemical agencies, dissolved and precipitated again, and has accumulated in strings, which sometimes form lenticular and more highly auriferous masses in the beds, and is associated with crystals of quartz, pyrite, chalcopyrite, galenite, blende, etc.

"The deposits which result from the disintegration of the rock, and subsequent denudation, are of great importance; there the gold, which was contained in the rock and in the small auriferous veins, which have been broken up into fragments, has been concentrated by nature, and deposited in the gravel beds; the quartz is frequently not even water worn, and many pieces still show the shape and thickness of the veins whence they came.

"The most extensive gravel deposits are in the South Mountains, and in Polk county; in Franklin and Nash counties; and in Montgomery county. The beds vary in thickness from a few inches to thirty or more feet, and are covered with soil, which is also auriferous, though much poorer than the beds below. These deposits have been worked for more than 60 years, and in some cases reworked with profit; and there are still virgin areas, which might easily be treated profitably by the hydraulic process. Vein mining *per se* in these regions has been but partially successful; for the rich veins are both narrow and too often shallow, and the large veins are of low grade.*

"The productive gravel of many localities is due to the breaking down of numerous small veins of sugary and granular quartz."

About one-half of the area of North Carolina is auriferous, but the productive part contains a little more than 12,000 square miles.

Warren county on the northeast, Moore county on the southeast, and the Tennessee line on the west, mark approximately the eastern and western boundaries of this gold field. It passes into Virginia on the north, and into South Carolina and Georgia to the south, and comprises the most productive part of the Appalachian gold belt.

The best known mines are on the central syenitic belt (for so it may be described in a general way), which stretches across the State from the northeast to the southwest, with a width of ten to twenty-five miles.

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*The application of the "Georgia method" of mining, i. e., by hydraulic process, followed by a mill treatment, where the work is quickly and cheaply and almost automatically done, has put a new face on this kind of mining. Something more will be said on this point, when the South Mountain section is described in detail, further on in this chapter.—G. B. H.

The towns of Greensboro and Charlotte are nearly on its axis. The area is tentatively classed as Lower Laurentian.

To the east is a large body of schists and slates, generally argillaceous, chloritic or talcose, and commonly with a very marked tendency to become siliceous; the width of this body is 15 to 50 miles; it also abounds in mines, but it has been less explored than the central belt. This formation is provisionally classed as Huronian (the Taconic of Emmons). A much more limited but interesting and important belt of these rocks lies to the southwest in Gaston, Lincoln and Catawba counties.

Still further east in Warren, Franklin and Nash counties is a narrow strip of gneiss (Upper Laurentian), in which the Portis mine district is situated.

To the west is a much wider formation, made up for the most part of gneissic schists, and extending, with a few interpolations of other formations, nearly or quite to the Tennessee border.

This area (Upper Laurentian) contains numerous mines.

The auriferous formations of the State will be discussed largely geographically.*

Gold Ores of Warren, Franklin and Nash Counties.

The extreme northeast deposits occur in Warren, Franklin and Nash counties, and cover, so far as explored, an area of about 100 square miles—fifteen miles along its northeast and southwest axis, and five to seven miles in width. The Thomas Mine, one and one-half miles northeast of Ransom's Bridge, is the extreme north point worked, so far as known. The area extends to the southwest beyond Peach Tree Creek, and nearly to Tar River. It is probable that the auriferous district is considerably more extended than these limits would indicate, but the productive area is practically confined in these boundaries.

The formation consists of gneisses and mica schists, for the most part, and is rich in ferruginous minerals, where peroxidation and alteration have extended far below the surface, and have given a deep red color to the tenacious clayey soil of the region. The entire area bears evidence of great surface disturbance, and rearrangement of the superficial material—probably of several rearrangements. The bedrock which is reached from 15 to 25 feet below the surface, is itself

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*See Appendices A and B.

much peroxidized and altered. A conspicuous phenomenon is the great abundance of quartz seams from a line to one and one-half inches thick. These commonly run with the bedding, but sometimes cross both the strike and dip. They are generally called veins, and are mostly of sugary or granular quartz, often seamed and filled with oxide of iron, and always soft and easily crushed. These small seams are frequently very rich.

The gold appears originally to have been largely in these narrow seams of quartz, which, in the process of weathering, have been broken down, and the fragments of which are widely distributed over and in the soil, becoming gradually more abundant, deeper below the surface on the bed-rock, in favored sinks or channels. From the analogies of the occurrence of gold elsewhere in the Carolinas and Georgia, it is probable that the entire "country" matter of gneiss, etc., may also have gold sparingly distributed within it, and from which it has also been concentrated.

Occasional masses of the "country" show a curious alteration, during which, apparently, the basic matter has been removed, and only the quartz left in a very soft and crumbly condition—an example of "silicification," which is very marked in some parts of the Appalachian gold field, and which has seemingly resulted in charging the entire mass with gold. Some assays of this material indicate it to be suitable for exploitation.

The richer parts of this district have been worked fifty or sixty years, but those which are most accessible to water, have been so far exhausted as to be no longer profitable under the simple methods of treatment so long practiced—and the use of these methods will gradually cease. Hydraulic operations on an extensive scale have also been attempted, and in the future probably will be prosecuted on a still more extended scale.

A large amount of quartz has been accumulated by such work, most of which is auriferous, and capable of being milled at a small profit.

Assays of such material give:

AURIFEROUS QUARTZ, PORTIS MINE REGION.	(81)	(82)	(83)
Gold, per ton	1-10 oz.	15-100 oz.	1-8 oz.
Silver, per ton	trace.	trace.	trace.

An exact study of this section has never been made, and a comprehensive statement of its resources is not possible now. All the mines

of this district have the same salient characteristics, and demand the same mode of treatment; some of them are situated on elevated lands, which are not well supplied with water.

The hydraulic methods, now largely applied in South Carolina, and still more extensively in Georgia, point out the general line of the solution of the mining problem here. A lift of water of 100 or even 200 feet, and with an added pressure equivalent to 50 or 100 feet of head at the point where the water is used, is now a small matter to the mining engineer. This column of water applied to a body of surface material rapidly "dissolves" the softer part of it, and washes it away, depositing its precious contents in the sluices, through which the current will bear the quartz, partly pulverizing it, and delivering it at some suitable point for milling. The outlay for the plant is not excessive, and, as the work is largely automatic, the expense of maintenance is small.

Very little work is being done in the mines of this region at the present time.

The more noted of the mines of the region, which have been worked, are the following:

The Portis Mine is in the northeast corner of Franklin county, quite near to both Nash and Warren. It is situated on a hill 108 feet above Shocco Creek, from which water for hydraulic work is obtained. This is the best known mine of the region, and has been worked longer and more extensively than any other,—the general characteristics of the group to which it belongs having been drawn mainly from it.

The Arrington Mine is in Nash county, one mile southeast of the Portis, and is believed to be in the same belt with the latter. The mine tract comprises nearly 2,000 acres of land extending two or three miles down Fishing Creek. After the Portis, this mine is the best known of the region.

The Thomas, Kearney, Taylor, Mann and Davis (in Halifax county), are other but less widely known mines of this region.

The Nick Arrington Mine is twelve miles east of the Portis.

The southeast extension of this Upper Laurentian area is overlaid by tertiary or more recent sands and clays, in which no gold deposits have as yet been discovered.

Gold Ores of the Central Huronian Belt.

In the Huronian rocks, in Moore county, gold ores occur in two belts, one 10 miles northwest of Carthage, and $\frac{1}{4}$ mile west of the Red Sandstone; the second is 8 miles further west, in the northwest part of the county, and is probably connected with the most eastern of the Montgomery county belts.

Bell Mine.—The Bell is the only mine in the former belt now worked. Here the country is an indurated siliceous schist, which may be easily mistaken for a talcose schist, but a closer examination shows that the talcose material is confined largely to the faces of the schist. This country is slightly mineralized, and several narrow belts occur, containing finely disseminated iron pyrite, which is generally more or less auriferous, as shown by assay No. 84 below. Assay No. 85 is of the peroxidized part of the same bed:

AURIFEROUS PYRITE, BELL MINE, MOORE COUNTY.

	(84)	(85)
Gold, per ton	1-20 ounces.	2-10 ounces.
Silver, per ton	38-100 "	8-10 "

The vein worked will probably be found to be one of these belts more highly charged with gold—a bedded vein. Its mass is a talco-chloritic schist, very siliceous and much altered. In many places the talco-chloritic matter has become almost entirely siliceous in seams, and in such cases is generally enriched. These seams, reddish to greenish in color, are commonly quite persistent in the direction of the strike of the "vein," but vary in width from $\frac{1}{8}$ of an inch to 4 inches. The ore body averages fully 4 feet in width. The ore is richer than its appearance indicates, as shown by the following assays of auriferous schists of the "vein," made from samples none of which showed more than traces of visible gold:

GOLD ORES, BELL MINE, MOORE COUNTY.

	(86)	(87)	(88	(89)	(90)	(91)	(92)	(93)
Gold, oz. per ton	3 38-1000	63 1-4	5 3-4	4-10	3-10	1 6-10	51	10 6-10
Silver, " "	1 56-100	16 12-100	2	55-100	7-10	trace.	8 24-100	3 64-100

The entire vein matter will average above $12.00 per ton.* There is very little sulphuret present. The gold is more than usually silvery, and is at the same time unusually "leafy." This last peculiarity has occasioned great trouble in practical work, and constitutes the great difficulty in working the ores of this mine.

The Bell Mine has been worked to the depth of 110 feet, and for a length of 800 feet.

The Grampusville Mine is in Moore county, 3 miles southwest of the Bell.

The second belt alluded to above as occurring in the northwest part of Moore county is extremely interesting, mineralogically as well as economically. The district, embracing 9 or 10 mines, is comprised in a space 2 miles wide from northwest to southeast, and 6 miles long from northeast to southwest. These limits indicate the productive part, but the actual auriferous area is considerably more extended. The formation is in a general way described as talco-chloritic, but it is everywhere very siliceous, and often the material deserves the name of siliceous schists. The phenomenon elsewhere alluded to is also observed here.† The talcose or chloritic material is frequently confined to the faces of the schists or to the joints, and rarely does the rock contain so large a proportion of these minerals as its external appearance indicates. It is worth while to add that a part of what passes for talc is pyrophyllitic and even hydro-micaceous. The formation is traversed by lenticles of quartz, sometimes conforming in an approximate way to the observed bedding, but quite as often across it. The diagrams

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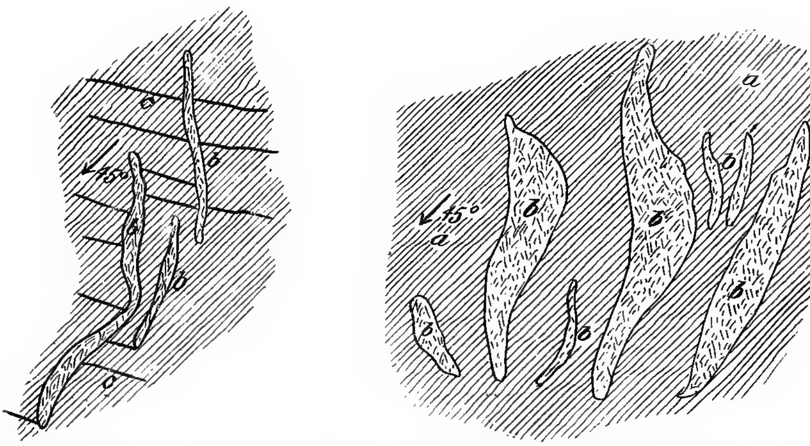
*In the course of a professional examination, I had occasion to make a rigid sampling of the entire body explored in the 75 foot level. The assays from the two drifts gave:

GOLD ORES, BELL MINE, 75 FOOT LEVEL.	(94)	(95)
Gold, per ton	675-1000 oz.	55-100 oz.
Silver, per ton	48-100 "	50-100 "

G. B. H.

†See page 242.

following, drawn from two cross sections seen in the Burns Mine, will show this fully:



Vertical cross sections of the siliceous talco-chloritic schist in the Burns Mine, Moore county, showing the quartz lenticles (b). The oblique light shading indicates the bedding of the schists, dipping west at an angle of 45°; the heavy black lines (c) of the left hand figure show the "joints." Drawn from actual sections, by Geo. B. Hanna. Scale 1 in. to 6 ft.

The surface of the country is strewn with quartz, which seems to have come from the long weathering of the strata containing these lenticles.

The "veins," so-called, are simply "bedded veins," and are the richer parts of the auriferous strata.*

Brown Mine.—This mine is in Moore county, on the northwest edge of the district, on the road from Moffitt's to Richardson's mill. It has been worked for a distance of 300 yards, and to a depth of 40 or 50 feet. The dip is very flat; the ore body is three feet thick, but the "pay seam" was a comparatively narrow seam of rich quartz, which, it is stated, finally narrowed down to such limits that it could not be profitably worked.

The *Bat Roost* and *Shields* Mines, in the same neighborhood as the above, have also been largely worked.

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* It is well to meet here a prejudice which is widely entertained;—that to speak of a vein as bedded is equivalent to an admission that it is neither rich nor permanent. A very large part of the mineral wealth of North Carolina (perhaps the larger part) is contained in these bedded veins, and they are fully as persistent in extent, and as rich and permanent in their contents as the so-called fissure veins.—G. B. H.

Cagle Mine.—This is located in Moore county, two or three miles southeast of the above, and near the east edge of the belt. It has a large mining tract of several hundred acres, mostly on the east side of Cabin Creek. The mine is worked through two underlay shafts in the vein, to a nominal depth of 160 feet. The ore body is a quartzose siliceous talcose schist, with a small amount (three to four per cent.) of iron pyrite and a trace of chalcopyrite. The ore body occasionally rises to be nine feet thick.

The work, unlike most of the mines of the belt, is nearly all under ground.* The machinery comprises 20 stamps.

Clegg Mine.—This mine is in Moore county, one-fourth mile west of the Cagle, on the opposite side of Cabin Creek. It has the same character of ore, but the ore-body is larger, i. e., the entire " vein " is ore, though of relatively lower grade. Above the level of the streams it is much altered and peroxidized, and soft—too soft for safe mining.

It is worked mostly by open cuts, and can be readily picked and shovelled out.

Burns Mine.—The Burns (or Burns and Alred) Mine, in Moore county, one-half mile south of the Cagle, is perhaps the best example of the class of ore deposits now under consideration. The mining tract proper is not large, but leased properties connected with it give an area of more than 300 acres.

It is difficult to say what is ore, and what is not, for the rock is everywhere auriferous, though not everywhere capable of being operated economically. The formation is a siliceous talcose schist, somewhat chloritic. Moody Hill, near the east boundary, and Brown Hill, toward the western, are the best known localities. The former has been most largely worked. In both places the mining has been largely by open cuts.

The selection of places for exploitation has been almost exclusively

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*I have made repeated assays of samples, which were thought to be just averages of large bodies of working ores, and were made for persons who had no interest in misrepresentation. Some of these assays are given below: nevertheless, (although the ore is very generally believed to be abundant), the returns have been extremely disappointing; and it ought in fairness to be said, that this mine has been (more than most mines) the resort of adventurers and process-men.

GOLD ORES, CAGLE MINE, MOORE COUNTY.

	(96)	(97)	(98)	(99)	(100)	(101)	(102)	(103)
Gold, oz. per ton....	1-4	1 9-10	1 288-1000	375-1000	3-10	35-100	2 3-10	2-10
Silver, " "	14-100	54-100	51-100	trace.	trace.	5-100	85-100	1-10

G. B. H.

determined by the results of mill runs of the ore, or by panning; and while this method of work has been wasteful in some respects, it was probably the best method available. The cuts are scattered about promiscuously, without much evident connection or relation, and are usually very irregular in outline. The cut most largely worked has, for its so-called foot-wall, a very siliceous schist, alternating with chloritic schists; while the hanging-wall is more chloritic and less quartzose; the bedding dips northwest 40° to 50°.

Here an ore body twelve feet thick has been exploited, assaying as follows:

GOLD ORE, BURNS MINE, MOORE COUNTY.	(104)	(105)
Gold, per ton	25-100 oz.	15-100 oz.
Silver, per ton	trace.	trace.

It is quite certain, however, that the material will not average so much in the long run, though working averages of $3.00 per ton may probably be depended on; and, at intervals, schists of high grade have been found, and may be encountered at any time.

This mine was operated for more than forty years, and while the old fashioned conservative methods were employed, viz.: by Chilian, and drag mills, the results were satisfactory; but more ambitious machinery and processes have failed entirely, to the injury of the good name of the mine and district. Under the old (and successful) methods the work was on a small scale, the machinery inexpensive, the capital small, and the attention to business unremitting.

The circumstances under which this mine has been profitably managed in the past will indicate not unfairly the conditions of successful work for all the mines of this belt (the Cagle possibly excepted), in the present state of the arts of mining and milling.

This belt extends one or two miles further south, and is apparently connected with the more easterly belt of Montgomery county, though the connection has not been thoroughly established.

In Montgomery county, also, the Huronian formation prevails, but the siliceous talcose schists, with a few exceptions, give place, toward the middle of the county, (reckoning from the east to the west, and on a line approximating to the northeast and southwest), to clay slates, thin-bedded and greenish gray in color*.

* C. C. Wade, Esq., of Troy, says: "We find but little gold south of a line north 45° east through the county with the center at Troy."—G. B. H.

The vein mines of this county have been very prominent in the mining history of the State. The gravel mines, of which there are a large number, have, through a variety of untoward circumstances, been less known.

There are three belts of auriferous territory in this county,* extending across the county from northeast to southwest.

The most easterly range embraces the Moore Mine on the northeast: the Reynolds, some six miles northeast of Troy; the Carter, a little nearer Troy, and the Sam Christian and Swift Creek, to the southwest.

The *Carter* and the *Reynolds* are on the same lead. The former has been worked to a depth of 100 feet; the latter to a depth of 80 feet. Quite recently another body of ore has been found on the Reynolds, some 600 yards northeast of the old works, and has been prospected to a depth of 40 feet. There is no record of the yield of these mines. Both of them contain telluret of gold, according to Emmons†.

Sam Christian Mine.—This mine has gained something more than a local reputation, and has been very productive of remarkably large and fine nuggets.

The gold in this mine is found in old "channels," in gravel of a thickness of one to three feet, and deeply covered with soil. The gold is rarely found in dust, but generally in nuggets of from five to more than a thousand pennyweights.

The tract contains 1286 acres, and has been worked in two places: "Dry Hollow," and the old "Sam Christian cut." Other channels are also known.

The method of work pursued in this mine consists in a removal of the soil resting on the gravel, followed by a very careful washing of the gravel in sluices and rockers. A slight "burden" of soil is removed by simple digging; in other cases it is washed away by hydraulic jets.

The "harvest periods" are uncertain and intermittent, since a long time is needed to remove the superficial matter in order to reach the gravel, and a few days or even hours will sometimes suffice for obtaining a large reward for weeks or even months of almost unproductive labor.

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* Some writers on the geology of this county reckon four, but between the third and the fourth, (the two western belts), it is not easy to make any practical distinctinction.--G. B. H.

† Emmons' Geology of the Midland Counties of North Carolina, 1856, pp. 168-169. Much of this information is given by C. C. Wade, Esq., of Troy, and R. M. Eames, editor *North Carolina Herald*, Salisbury.

The obvious method of treatment is the hydraulic, but as the mine is elevated 190 feet above the adjacent water courses, and there is, moreover, a very scanty supply of water in the gulches which cut the hills, the greatest economy allows of only a moderate amount of work in the most favored seasons. A survey to the Yadkin River, at Swift Island Ford, three miles distant, shows that a large supply of water from this source is possible.

The second belt is four to six miles northwest, and comprises a line of "gravel" mines on the northwest of the Uwharrie Mountains, and between them and the Uwharrie River. The northernmost limit of these gravel mines is known to extend to Barnes Creek, and may even reach to within 5 or 6 miles of Ashboro.

The localities best known and most worked are the Bright, Ophir (or Davis), Spanish Oak Gap, Dry Hollow, Island Creek, Deep Flat, Pear Tree Hill, Tom's Creek, Harbin's Bunnell Mountain, Dutchman's Creek, and the Worth, the latter being near the junction of the Uwharrie and the Yadkin. Bedded veins are known to exist at some of these localities, but their value is unknown.

All of these were largely and profitably worked as long as the naturally concentrated material lasted, and the proximity of water favored work. At present the supply of available water is entirely inadequate for the working of these properties, and the tailing ground is not always favorable. The presence of a tenacious clay with the gravel has also caused difficulties in the treatment.

The third belt is still further to the west, but not remote from the second.

Many of the mines of this belt have been long worked, and have at times been very prosperous. Among these are the Steel, the Saunders (an extension of the Steel), the Henderson, Appalachian (Coggins), Morris Mountain, Russell (or Peebles), and the Beaver Dam. The first two, which are about two miles southeast of Eldorado village, and on the east side of the Uwharrie River, are now one property, owned and worked by the Genesee Gold Mining Company. The Henderson is also near Eldorado, and is hardly more than a series of prospecting pits. The Coggins is just to the east of it. The Morris Mountain, or Davis, is northwest of the village, and between it and the Russell, which is two miles northwest.

Russell Mine.—This mine will serve as a type of several mines in this region, and having been worked more extensively than any other,

has allowed better opportunity for study. A brief description of the characteristics of this mine will indicate the salient features of most of the others.

It is located in the northwest angle of Montgomery county, near the Randolph line, and not very far from the southeast corner of Davidson county.

The schists of the region are not strikingly different from those of many other places in this part of the county, and in the adjacent parts of Randolph. They bear north 26° east, and dip west about 70° Evidently there have been great alterations; the resulting schists varying in color from a gray, with silvery lustre, to black. The term talcochloritic is generally used to describe them, but they are really an extremely hard siliceous schist with talcose or chloritic, or even prophyllitic partings; but these latter minerals do not commonly enter to any considerable depth into the body of the rock.

The schists are usually as thinly and evenly laminated as a roofing slate; but they break easily and irregularly into small angular fragments not unlike gun-flints in size and form.

Pyrite (with the merest traces of chalcopyrite) to the extent of from 2 to 4 per cent., is almost universally present in the schists; sometimes occurring as a brilliant veneer on the transverse joints, and more often on the bedding faces. Occasionally true chloritic schists make their appearance. Much more frequently seams of quartz occur, the quartz having a decided bluish cast, though at times it is nearly white, and again in places has a reddish tint. It is commonly believed that an increasing intensity of the blue tint is accompanied by an increase in the quantity of gold present.

There is no appearance of a fissure vein at this mine. The entire formation is gold-bearing, but only certain strata contain it in quantities large enough to warrant their being worked.

To one unfamiliar with the formation, it is difficult to distinguish any difference between the richer strata and the poorer, except possibly in the fact that the former show somewhat more of alteration; and even the miner, long familiar with the region, is often at fault, and ascertains his true course only by constant "panning."

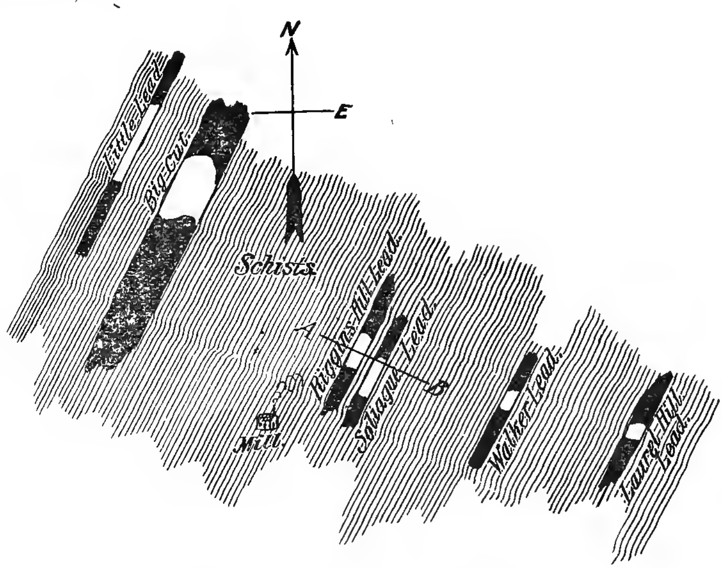
Occasionally the working body jumps abruptly, in one case not less than ten feet, and sometimes further on resumes its old course. The change in grade is even more perplexing, for the external signs of rich and poor ore are of the vaguest kind.

The gold-bearing material, like that of all the similar mines of this region, is of very low grade, as may be seen from the assays given below. But it may be added that these rich seams appear and disappear abruptly and without warning.

GOLD ORES, RUSSELL MINE, MONTGOMERY COUNTY.

	(106)	(107)	(108)	(109)	(110)	(111)
Gold, ounces per ton	21	1-4	1-2	35-100	7-10	15-100
Silver, ounces per ton	3 32-100	85-100	82-100	47-100	1 2-10	17-100
	(112)	(113)	(114)	(115)	(116)	(117)
Gold, ounces per ton	1-10	1-10	1 1-10	2-10	15-100	20 1-2
Silver, ounces per ton	2-10	5-100	1-10	8-100	trace.	9 34-100
	(118)	(119)	(120)	(121)	(122)	(123)
Gold, ounces per ton	11 1-2	45-100	4 1-10	45-100	1 9-10	8 4-10
Silver, ounces per ton	4 88-100	65-100	1 6-10	30-100	6-10	2 4-10

The accompanying figure will show the relative position of the several "leads" of the Russell mining tract, and the localities where work has been done:



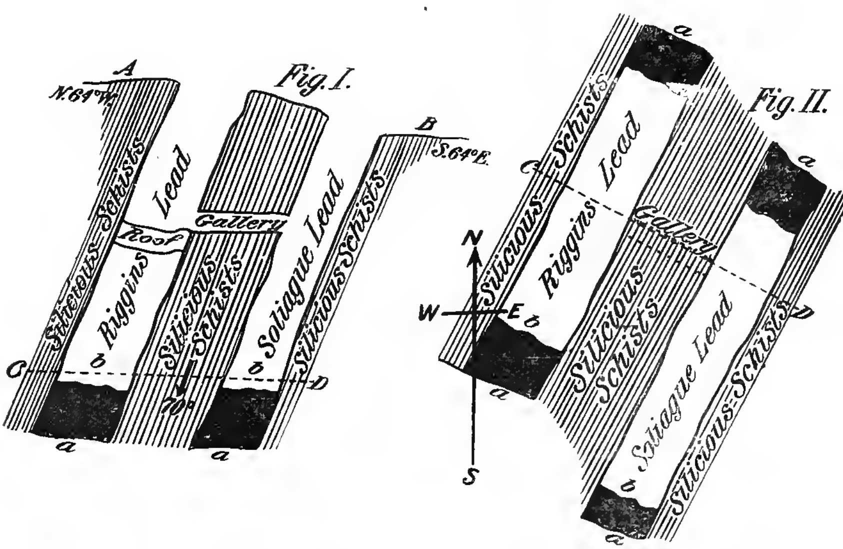
LEADS OF THE RUSSELL MINING TRACT,

A horizontal plan showing the relative position of the "leads" (colored black) and the areas worked to date (blank spaces in the black.) By Geo. B. Hanna.
Scale, approximately, 1 inch to 750 feet, with the width of the leads exaggerated two-fold. The leads do not end abruptly in the schist, as indicated on the figure.

A glance at this sketch of the leads shows that the auriferous territory across the formation from northwest to southeast is fully 2,000 feet, i. e., the belt is 2,000 feet wide.

This mine is now operated by a London company, but not yet on the grand scale commensurate with its large resources.

The sections given below, on a larger scale, will show the methods of work adopted, and the relations of the working bodies:



RUSSELL MINE, RIGGINS AND SOLIAGUE LEADS.

Fig. I, a vertical cross section on the line *A B* of the plan of the "Leads of the Russell Mining Tract," above. Fig. II, a horizontal cross section or ground plan through the line *C D* of Fig. I. (By Geo. B. Hanna). The portions of the leads colored black are as yet unworked, the space being occupied by auriferous siliceous schists, similar to those between and on either side of the leads, except in the latter not being auriferous. The portions of the leads left blank have been worked already. Scale, 1 inch to 60 feet.

Morris Mountain Mine.—This mine, sometimes known as the Davis or Dutton Mine, is located in the northwest part of Montgomery county, 1 mile nearly west of the Coggins (see below).

Here the occurrence of the gold appears to be quite similar to that at the Russell—in "bedded veins."

As yet it has been barely touched, and its capabilities are unknown. Assays of its ores by Hanna show the following contents:

GOLD ORES, MORRIS MOUNTAIN MINE.	(124)	(125)
Gold, per ton..................	4 ounces.	175-1000 ounces.
Silver, per ton	trace.	53-1000 "

The gold occasionally concentrates in the natural joints, and the faces of these joints are sometimes enormously rich.

Appalachian Mine—The Appalachian (or Coggins), located in the northwest part of Montgomery county, one and one-half miles northwest of the Steel, is, so far as has been worked, suggestive of the same characteristics described as belonging to the Russell Mine.

The schists have a strike N. 40° E., and dip steeply to the northwest; they are quite similar to those of the Russell, though possibly less siliceous or more chloritic.

At the surface there appeared to be two ore bodies separated by a narrow and comparatively barren bed of schists of like character. Assays give:

GOLD ORES, APPALACHIAN MINE, MONTGOMERY COUNTY.

	(126)	(127)	(128)
Gold, per ton	5 1-2 oz.	225-1000 oz.	1-10 oz.
Silver, per ton..............	1 "	125-1000 "	1-10 "

This mine, as far as developed, shows large bodies of low-grade ore similar to those of the Russell, yet ores that are easily within the limits of profitable work. The second of the assays given above will probably be below the tenor of the contents of the mine,—in its upper part, at least.

The *Steel Mine*, and its extension, the *Saunders*, are on the east side of the Uwharrie River, and two miles southeast of Eldorado village.

This mine has been described with as much fullness as space will allow in the chapter on Silver (page 199).

Beaver Dam Mine.—This mine, at Flaggtown post-office, 2 miles northeast of the junction of Beaver Dam Creek and the Yadkin River, contains a mining tract of 800 acres, one-half of which is claimed to be underlaid with gravel. This gravel is from 2 to 4 feet thick and overlaid by an alluvial deposit 5 to 15 feet thick. Numerous seams of quartz everywhere course through the schists, and are probably the largest source of the gold, but it is likely that a considerable amount also came from the breaking down of the schists themselves.

There is a fair supply of water afforded by the Beaver Dam Creek for hydraulic operations,—the only method feasible here.

Operations on a large scale have always been hindered by the mechanical difficulty caused by the tenacious clay, which is everywhere mixed with the gravel, and has a tendency to "ball" and carry off the gold.*

Other deposits worthy of mention are the Griffin Mine, one and a half miles N. E. of the Russell, and the Nall, near Stokes' Ferry.

In Randolph county the Uwharrie and Hoover Hill mines are the only ones now at work. However, these two mines do not exhaust the list, for like Montgomery county, there are many localities, which in their time have been productive.

No trustworthy statement can yet be made respecting the relation of the subordinate belts, but from their alignments, they appear to be the northeastward extensions of the two western belts of Montgomery county. The formation is the familiar schist ("slate"), but in places, —e. g., vicinity of Hoover Hill,—these are so altered as to have the appearance of an eruptive rock.

The Uwharrie Mine is a short distance to the northeast of the Russell just over the line in Randolph county.

The formation is for the most part the same as at the Russell, and calls for no detailed description. The entire mass of gold bearing schists is believed to average $10 per ton, and to carry 1½ per cent. of iron pyrite.

Unlike the Russell Mine, the work here is under ground. The shaft has been sunk to a depth of 170 feet. The 70-foot level has been driven N. E. 84 feet, and S. W. 60 feet; the 120-foot level N. E. 50, and S. W. 35 feet; and the 170-foot level has just been started.

The mode of treatment adopted is substantially the customary method of the region—battery and plate amalgamation of free gold, and concentration of the sulphurets from the tailings. These concentrates are intended for metallurgical treatment.

The Winningham and Slack mines are in Randolph county, two and a half miles south of Ashboro.

The Davis Mountain Mine is four miles southwest of Ashboro. The Sawyer Mine is five miles northwest of Ashboro. At this locality the

* The fall from the gravel bed to the river along Beaver Dam Creek is one inch per rod for a distance of one and a half to two miles. The rock in the hill is a decomposed quartzitic schist, as at the Jones Mine.

ore body is massive and consists of parallel beds of siliceous talcose schists in an advanced stage of disintegration, and sometimes forming a body of fine, loosely coherent sand. These schists are auriferous, and the workable bodies are sufficiently near each other to be worked at the same time.

The Winslow is five miles southwest of Ashboro.

The Jones, or Keystone, the Lafflin (Laughlin) or Herring, and the Delft are in proximity to each other, and are of like character.

The Jones Mine.—This mine, the first named in the above list, has been most largely worked, and has for that reason received a closer study; a description of it will indicate the character of the others.*

This mining tract has 293½ acres, and is situated in Randolph county, 12 miles a little east of south from Thomasville, and near the Davidson county line. The schists of the country are soft and rather siliceous, with a chloritic tendency. The weathering to a depth of fifty feet or even more, has brought about a peroxidation of the ferruginous constituents, so that the formation is now a mass of reddish earth, which can be readily picked to pieces. Ordinarily, the more deeply colored the earth, the richer it is. Gold is universally present in the soil of the region, but the mining is confined to certain well known belts, which are more richly charged with it. Occasional horses (or "bars") of the strata are found charged with finely disseminated iron pyrite, and being as yet slightly altered, are still solid and firm; these (unless very rich) are usually avoided from the comparative difficulty both of mining and milling. The presence of the gold is apparently most largely due originally to the presence of iron pyrite,† which, through peroxidation, sets the gold free; but it cannot be overlooked that in the belts richest in gold, fine quartz is also more abundantly distributed and in such a manner as to suggest some close association of the two.

The schists course N. 40° to 60° E., and dip 80° to 85° from the horizon. They are jointed in every direction.

Two of these belts have gained especial prominence, one being 50 feet wide, the other 110 feet.

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* Emmons' Geology of the Midland Counties of North Carolina, 1856, pp. 131–3.

† It is generally conceded by most students of this "slate belt" that the charging of gold was contemporaneous with the deposition of the sediments, but secondary concentration of the gold must have been general, and a necessary result of the extensive metamorphisms which the sediments have undergone.—G. B. H.

But there are numerous openings on every part of this tract, from every one of which auriferous material may be obtained.

The strata, which are comparatively barren, are easily recognized, and readily avoided. It is doubtful if there be a fissure vein here, but there are occasional masses of quartz, which apparently indicate bedded veins.

In a word, the mine is simply a series of ore-quarries, and is worked "open-cut," as quarries generally are worked. The tract is everywhere cut by gulches, which allow easy access and cheap entry into the bodies of ore, and at the same time facilitate easy transposition, by gravity tramways, to the mill.

The character, the occurrence, and the distribution of the ore, are such, that new bodies, equal in value to any that have been hitherto worked, may at any time be exposed.

The disintegrated condition of the rock (soil) allows of mining at a marvellously cheap rate, frequently not exceeding 15 cents per ton of ore delivered in the mill-house. Undermining in largely practised.

The material is low grade, but it changes perpetually in its contents, and bodies of relatively high grade material (assay 134) may be met with at any time, but the extent of these rich strata is limited. The assays give:

GOLD ORES, JONES MINE, RANDOLPH COUNTY.

	(129)	(130)	(131)	(132)	(133)
Gold, ounces per ton..........	15-100	3-10	1-8	15-100	1-10
Silver, ounces per ton.........	8-100	trace.	trace.	2-100	trace.
	(134)	(135)	(136)	(137)	(138)
Gold, ounces per ton..........	1 4-10	225-1000	1-10	225-1000	233-1000
Silver, ounces per ton.........	trace.	trace.	trace.	10-100	10-100
	(139)	(140)	(141)	(142)	(143)
Gold, ounces per ton..........	2-10	15-100	14-100	2-10	175-1000
Silver, ounces per ton.........	trace.	trace.	trace.	trace.	trace.

Strict averages of large bodies of accumulated material, or reserves easily accessible, gave fairly uniform results (see assays 129, 132, 137, 141, 142 and 143 of such bodies), so that it may be said with fairness, that the average value of working bodies will not fall under $3.00 per ton.

No. 134 was taken by accident from a place which did not in the slightest degree indicate any superior value.

Mining has been carried on here for two generations, and as long as

the rich shoots and the concentrated material lasted, it was profitable, but when the resources worked down to the low grade ore, the old methods were no longer applicable, and the work became very fitful. The treatment latterly employed is that by stamp battery, and is apparently the best available with the present supply of water, which consists of one small stream and the accumulations in dams during the rainy season.

The indispensable condition of success with low grade mine stuff of this character is the handling of large quantities, which can only be effected by means of a large and constant supply of water.

It should also be noted that the surface might readily be subjected to hydraulic treatment, if a supply of water with a strong head were practicable.

The nearest source of supply is the Uwharrie River, a bold stream, some two miles away, but at a lower level. But probably an engineer would find no great obstacle in bringing its waters to the mine.

The Parish Mine at this mining tract, is a vein, whether fissure or bedded is unknown.*

The ore body is hornblende (frequently actinolitic), and chloritic, both gold bearing, especially the hornblende.

A few fragments cut from the walls of the shafts gave (two samples) respectively, $14.90 and $88.50 per ton. The deepest shaft on the body was the Robbins' shaft, 68 feet deep.

Hoover Hill Mine.—This mine is located in Randolph county, 17 miles a little east of south from High Point. It has for some years been worked by a London company, and latterly with success.

The country, which is hard and compact, is traversed by belts, which abound in quartz seams, ranging from a line to a foot in thickness. The seams are not regular in their belts, but the belts themselves exhibit a marked persistence. The weathered outcrops of these seams were extraordinarily rich, and gave the mine its early fame. The gold in depth is invariably associated with the quartz seams, though they sometimes occur without enriching the ore body. Iron pyrite is present to the extent of three per cent., and it is generally found on the sides of the quartz seams, between them and the accompanying gangue.

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* At the time of the Editor's visit it was filled with water, and its relations were unknown.

The quartz seams or strings are very abundant in these belts, and do not disappear with the pocket of ore.*

There are several of these ore belts: the principal one is the old "Briols Shoot," entered by both the Briols and the Gallimore shafts, and has been most largely worked. The former shaft is considerably more than 300 feet deep. The ore body at this depth was large, and worth $8.00 to $10.00 per ton.

At no great distance from the Briols shoot are six other belts lying quite closely together, and worked from the Hawkins shaft, which is now about 150 feet deep. These ore bodies fluctuate considerably both in size and grade, and are frequently interrupted by cross courses of greenstone.

The strike of the vein approximates a N. E. and S. W. direction, and its dip is to the eastward, 60° (to 30°) from the horizon. The ore body in the Briols shoot has a dip of its own, northward in the vein.

The Wilson Kindley Mine is situated one-half mile southwest from the Hoover Hill; and the formation is like that of the latter mine.

It will easily be perceived from this brief discussion of the occurrences of gold in the counties of Randolph and Montgomery, that the extent of their auriferous wealth is beyond our present power to estimate. Probably no other equal area in the State has anything to compare with it. Very little of this area is now available for profitable work, but the introduction of cheap and powerful explosives, and of cheaper and more efficient machinery, has considerably widened the area of profitable work, and will continue to do so indefinitely. The weak and critical point of the industry lies in the inability of the milling machinery to save the gold. This is not surprising, for with such low grade ores, yielding gold to the amount of not more than $3.00 to $5.00 per ton, whatever is gained may be easily lost in the increased cost of the work; nevertheless there is constant progress.

The solution of the problem of putting these vast and unique stores of gold into the channels of commerce lies, if a conjecture may be hazarded, not so much in the introduction of any new process, which will supersede amalgamation, but in the perfecting and cheapening of the art of mining, and in the increased efficiency of the modes of amalgamation. There are also many petty economies, which may be prac-

* Neither do the auriferous contents entirely give out. The gold is not absolutely wanting, but is in too small a quantity to allow of profitable work.—G. B. H.

ticed. It is also probable that a well devised system of automatic concentration applied to the "tailings" will materially enlarge the field of profitable mining.

At the present time there are no means of profitably disposing of the low grade concentrates which can be made from these ores containing, as they do, rarely more than $20.00 per ton.

The most western of the Montgomery belts is believed to pass into Stanly county, where gold is widely distributed, and not less than twenty localities (mines) have earlier or later been worked. At the present time only the Parker, the Crowell, and the Barringer are in operation, together with a few petty hydraulic enterprises. Among the more noted mines are the Haithcock and the Hearne, a little more than two miles northwest of Albemarle.

*The Hearne mine,** in Stanly county, two miles northwest of Albemarle, is traceable for a mile or more on the surface, and on the northeast it passes into the Haithcock. The strike of these veins is N. E. and S. W.

The *Haithcock* at its northeast end runs into and merges with the Lauder, which has a course N. about 70° E. The former veins are 2 to 4 feet wide, the latter 6 feet. Both are evidently largely filled with quartz Their old reputation is good.

Parker Mine†.—The Parker Mine, in Stanly county, at Bilesville, 10 miles southeast of Gold Hill, has a small but very rich tract of some 3 or 4 acres. It has yielded a large number of nuggets, all of which—estimated to have an aggregate value of $200,000.00—have been taken from the surface or from very shallow pits. The nature of the surface is strongly suggestive of the Portis and the Shuford mines, and like those localities, needs hydraulic treatment.

Some recent deep work has shown that the opinions as to the permanent richness and depth of this mine need modifications; the quartz veins are considerably more permanent in depth than was formerly supposed.

The veins or seams extend for more than 3000 feet. There are 3 main veins, having a strike N. 30° to 40° E., and a dip 50° to 60° West. Other seams do not conform either in dip or strike, but run in various directions. These veins or seams range from 6 to 18 inches in thickness, and sometimes even more, and are everywhere accompanied in

* Emmons' Geology of the Midland Counties of North Carolina, 1856, p. 167.

† Description written in December, 1887, as the report is being printed.—J. A. H.

depth by lenticles of quartz from a line to 4 inches in width. The schists accompanying the veins are auriferous for 2 or 3 feet on both sides of the vein. Masses of chlorite schist are occasionally found with free gold imbedded.

Assays of the average of large bodies of quartz (143 a) and auriferous schist (143 b) are as follows:

GOLD ORES, PARKER MINE, STANLY COUNTY.

	QUARTZ BODIES (143 a)	AURIFEROUS SCHIST (143 b)
Gold, ounces per ton	65-100	35-100
Silver. ounces per ton	25-100	15-100

Nuggets in abundance continue to be found, while quartz with gold attached is often met with; the material is always free milling.

Through weathering, the gold has been widely scattered through the surface soil to a depth of 10 or 20 feet. Large areas of gravel, and several gulches are rich enough to repay in large hydraulic operations; and the fragments of ore which they contain, sometimes to the extent of one-fifth of the whole bulk, constitute a valuable ore, admirably suited to mill work.

The immediate formation of the Parker Mine is chloritic (sometimes hornblendic) schist, with a variety of obscure porphyry. The weathering agencies have reached to a depth of a hundred feet or more.

Flint Spring Mine, one-fourth mile northeast, is of like character. This mine and the Parker now form one property, on which work has been begun anew by London parties, who have installed a large and admirable plant.

Crowell Mine.—This mine is in Stanly county but a short distance from the Parker. It has a bedded vein, with an ore body 4 to 7 feet thick, which will frequently pay to work as a whole. The "ore seam" is much narrower, and often becomes only a line in thickness.

The ore bed does not differ in a marked degree from the adjacent "country," for both are auriferous Both are talcose with a chloritic tendency, and in altering become quite siliceous; they contain finely disseminated pyrite, peroxidized in the upper works. The strike is N. 10° W., and dip W. 42° to 45°

The mine has been worked to a depth of about 125 feet. The range of value of the working ores is indicated by the following assays:

GOLD ORES, CROWELL MINE, STANLY COUNTY.

	(144)	(145)	(146)	(147)
Gold, ounces per ton	1 155-1000	495-1000	8 15-100	7-20
Silver, ounces per ton	trace.	13-100	55-100	7-10

Barringer Mine.—This mine is in Stanly county, 4 miles southeast of Gold Hill. Enormously rich ore is occasionally found, but the mine has been so long and so largely in litigation, that no considerable exploratory work has yet been done. The ore is frequently very deceptive and assays much richer than its appearance warrants, viz:

GOLD ORES, BARRINGER MINE, STANLY COUNTY.

	(148)	(149)	(150)	(151)	(152)
Gold, ounces per ton	26 1-8	16 3-4	1-4	1-10	1-4
Silver, ounces per ton	3 1-2	1 3-4	1-4	1-5	1-5

None of these samples differed much in external appearance.

The western strip of mining territory in Stanly county is adjacent to Gold Hill, and forms part of the belt stretching from Davidson to Union counties, to which allusion has already been made. In this belt the mines of Union county, with two or three exceptions, are connected by a series of intervening ore deposits with the Gold Hill, Silver Hill, Conrad Hill, and other mines of Davidson county. This rich metalliferous region, 75 miles in length, contains many of the noted and productive mines of the State. It is in the extreme west of the Huronian area, and in immediate proximity to the granitic and syenitic area (Lower Laurentian), which crosses the central region of the State. Its richness in copper, lead, etc., has been elsewhere discussed (pages 188 and 211).

Its gold mines will now be considered. This belt commences at Conrad Hill, near the Three Hat Mountain, about the middle of the eastern boundary of Davidson county, and runs through it in a direction nearly S. 40° W. to the southeast corner of Rowan (and the adjacent corner of Stanly), through the eastern part of Cabarrus, and the western part of Union county, nearly to the South Carolina line.

The mines of Union county are mostly in the above-mentioned belt, and are near the western edge of the county, adjacent to Mecklenburg. They are in schists, but not far remote from the syenite and granite. The whole extent of this belt in Union county is, with scarcely a break, crowded with mines.

The ores are readily classified into auriferous and argentiferous galenite, auriferous pyrite, and auriferous schists; but sulphurets are never absent from the latter. Copper ores are of incidental occurrence, but are not known to be present in quantity.

The only mines now worked in this county are the Howie, Putnam (Stearns), Phiffer and Hemby.

The Howie, Wyatt, Washington and Penman make up the "Grand Union Gold Mine," with a tract of 1941 acres.

Howie Mine.—The characteristics of the group will be best understood by a description of the Howie Mine, Union county, one and a quarter miles northwest of the Washington (see below).

It has been worked more extensively, and has received more study than the others of the group.

The ore body is 400 feet wide and fully one mile long, running N. 60° E., and has been worked a large part of this distance. It is difficult, however, to say where "vein" matter is not found, as the rocks of the entire region are gold bearing, as well as the so-called veins. The formation consists of schists, which are argillaceous with a marked siliceous tendency,. dark colored, and extremely hard. They are penetrated by numerous seams of quartz, which generally have the effect of enriching the ore body.

The schists are usually altered and peroxidized down to the level of standing water, and the ore to this depth is soft and easily treated; below the water line it becomes extremely hard. Pyrite, to the extent of about one per cent., is widely disseminated, and occurs somewhat more abundantly on the faces and the joints of the schists. As the rock is extremely hard, most of the shafts, although filled with water, are still intact. The deepest of the shafts is the Cureton, 300 feet deep. The workable ore exists in shoots or chimneys, with a dip of their own in the vein. The mine stuff rarely shows, by its external appearance, what material is, and what is not rich enough for remunerative work, and this is determined by constant tests. The numerous but small seams of quartz seldom show more than a trace of gold, but the richest portion of the ore is where the quartz is most abundant. Other parts of the tract show large bodies of soft, clay-like, auriferous material, which has been successfully treated.

A brief consideration of these remarkable deposits show that a deficiency in ore supply is impossible. They are ample enough to supply several independent plants. The ore, as might be supposed, runs through a wide range of values. The average of 12 assays of the "soft ore," by Prof. Spears, of New York, gave for the gold and silver contents a value of $14.63 per ton; and the rubbish piles were shown by him to carry $3.26 per ton. The examination of various bodies in the tailings show that a surprising amount of gold was lost in the mill

work. In truth, a portion of this material is as rich as the standard ore at some of the "slate" mines.

The following assays of these tailings are by Hanna:

ASSAYS OF "TAILINGS," HOWIE MINE, UNION COUNTY.

	(153)	(154)	(155)	(156)	(157)	(158)
Gold, ounces per ton	1 45-1000	4-10	1 383-1000	925-1000	4 15-100	284-1000
Silver, ounces per ton......	trace.	1 3-10	867-1000	1 175-1000	1 2-10	trace.

Samples for assays Nos. 153 and 154 came from the waste piles, and showed in no wise different from the great mass of the piles. No. 158 is the assay of a tailings sample from old "tailings yard."

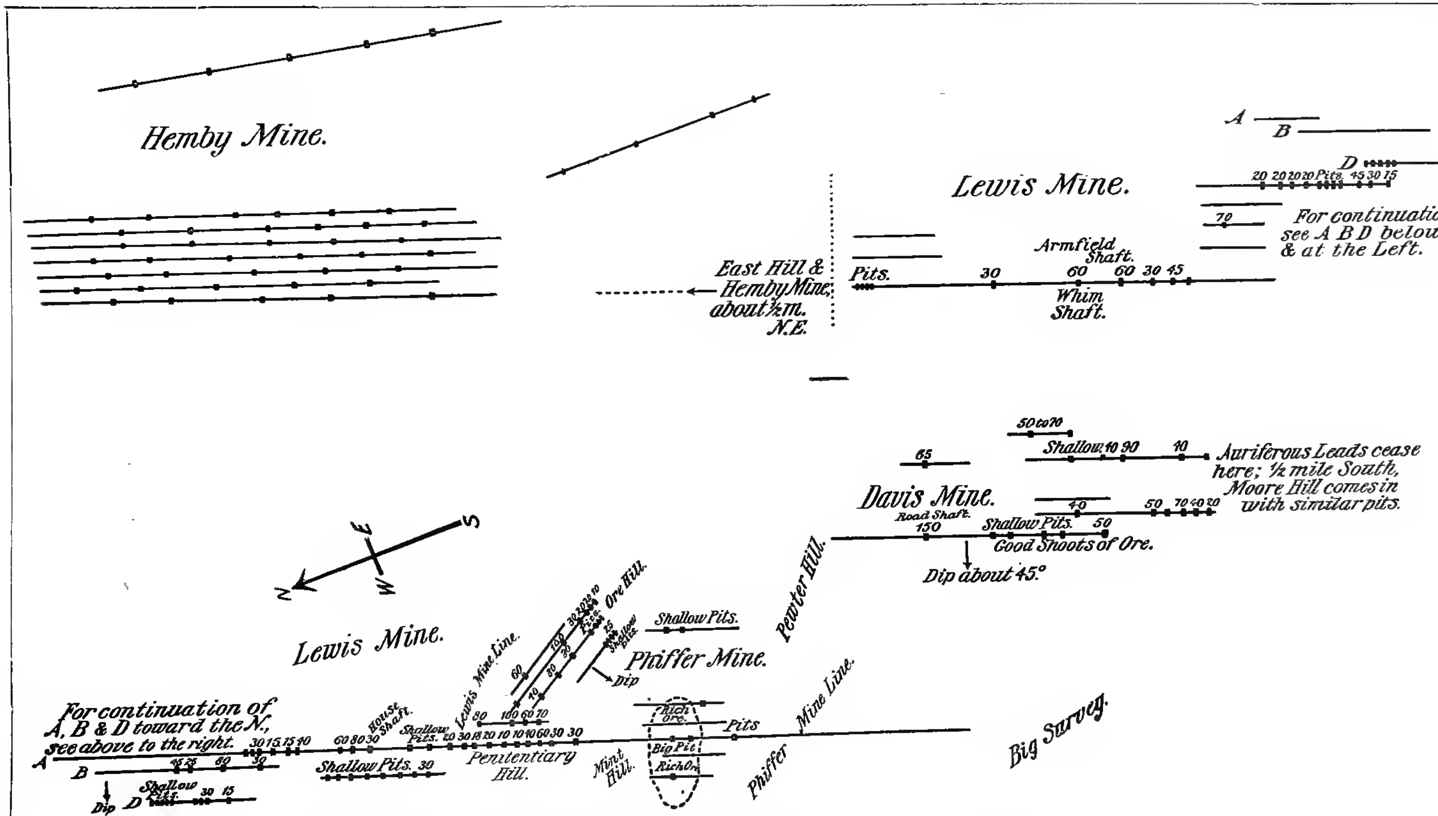
The Washington Mine is 8 miles distant, a little south of west from Monroe, and is the most southerly of the important mines of this county. About 20 shafts have been opened; and the ore bodies are reported to have been found quite rich. The ore is a hard, dark-colored, auriferous schist, with a small per centage of iron pyrite, and has a good reputation.

The "Big Survey" lands come in between the Howie and the Davis mines, 2½ miles northeast of the former. The corporation owning this intervening tract has been unwilling to part with mining rights in selling its lands, and has, thereby, discouraged mining operations. The mineral value of the tract is unknown.

Davis, Phiffer, Lewis and Hemby Mines.—At the Davis commences a remarkable series of mines, four of which lie in regular succession from southwest to northeast, viz., the Davis, Phiffer, Lewis and Hemby. For the distance of nearly two miles there is an almost unbroken series of pits and shallow shafts.

Plate No. XVII shows the larger part of this series. On the plate, except when specified to the contrary, the distances across the series are exaggerated to allow of proper representation. The figures accompanying each pit or shaft indicate the depth of the same. The whole body of schists for the entire length of the series of mines, and for a great width, are auriferous, but the workable strata are of course much more limited, and the productive parts jump from one bed to another parallel bed quite frequently. Auriferous deposits, running across the strata, although not unknown, are not frequent.

The vast number of pits shown is the result of petty leases (which will also account in great part for the shallowness of the pits), and incidentally bears witness to the value of the deposits, which have



MAP OF THE DAVIS, HEMBY, LEWIS AND PHIFFER MINING TRACTS.

Scale 1 inch = 275 feet (approximately). The lines indicate the outcrops of auriferous strata; the black dots on them indicate pits and shafts, the depth of which are indicated by the adjacent figures.

been very rich, especially on the Phiffer tract, where, on Mint Hill, an open cut 100 feet in diameter and 50 feet deep, was worked out. Petty work is constantly going on along the whole line, but none of the mines are systematically operated.

The Lewis has two, and possibly more, veins; the Hemby has several, three having been reported already. At the Hemby mine the latest work reached a depth of 125 feet, but the extent of the work was not sufficient to admit of a statement as to the value of the underground resources. Assays of the ore from this mine give:

GOLD ORES, HEMBY MINE, UNION COUNTY.

	(159)	(160)	(161)	(162)
Gold, ounces per ton....	3-8	1 5-8	7-20	1-4
Silver, ounces per ton.........	1-2	85-100	1 93-100	8-10

The schists of this stretch of mines, and of the mines still further northeast, are known as "clay slates," but in reality they partake of the mixed characters of clay, quartzitic, chloritic and talcose schists, as has been elsewhere alluded to. Sulphurets are sparingly disseminated. Allusion has been made already (page 189) to the fact that galenite in small proportion is frequently found in these ore deposits, and to its influence in degrading the fineness of gold bullion.

The Moore Hill Mine is situated one mile southeast of the Davis.

The Folger Hill is one-half mile west of the Davis. This mine has been worked to a depth of 90 feet.

The Harkness is one-half mile east of the Lewis. It was mined to a depth of 120 feet, at which depth was found a fine quartz vein, showing free gold abundantly.

Northeast of the Hemby there is a region abounding in mines, where, first and last, considerable work has been done; but no authentic records concerning them can now be found, and there are no data accessible for a detailed statement. In many cases hardly anything more than their names now survive. Prominent among these are the following: the Long, Henry Phiffer, Crowell (Bright Light), Fag Hill, Dulin, Moore, Crump, Smart, Stewart, Lemmonds, etc.

The Moore, Smart and Lemmonds were described in the chapter on Silver and Lead (pages 189 and 190.)

The Crump Mine is in Union county, 4 miles south from Stout's Station, on the Carolina Central railroad. It is noted for its remarka-

ble pockets, and splendid and peculiar nuggets, in which nearly all the gold occurs.

The Stewart Mine is towards the northern part of Union county, and 15 miles nearly southeast from Charlotte. It has been prospected at points for more than 200 yards, but the greater part of the mining work has been done in one-half this space. The greatest depth reached was 170 feet.

A very rich shoot of ore was found, but it was subsequently lost, and a great deal of costly but useless work has been expended in searching for it. For the characteristics of its lead ores the reader is referred to page 190.

The belt continues into Cabarrus county, and northward towards Gold Hill. The only mines of which it is necessary to speak in detail are the Reed and the Rocky River, the Allen Furr (or "Silver Valley") Mine having been noticed already (page 191).

The Reed Mine.—This mine is in Cabarrus county, 10 miles southeast of Concord. It was the first mine to give celebrity to the gold-fields of the Appalachian range, though probably not the first to yield gold.

The first nugget at this mine was found in 1799; the largest nugget, weighing 28 pounds avoirdupois, was discovered in 1803. Regular mining work was commenced a few years after this latter date, and during the subsequent period of 40 years, the mine yielded large quantities of gold.

The proportion of large nuggets has not been paralleled on this side of the Continent, though the Sam Christian has had a similar history, as has also the Parker Mine. The Reed, unlike these mines, has large under-ground resources.

The tract comprises 780 acres of land, which lie in the schists (talco-chloritic and rather siliceous) though near the granite. Gold is here widely diffused, and the deposits along the branches, of which there are several on the tract, yield promising results.

Nothwithstanding the "gravel" has been so long worked, there are some "hollows" or "sinks" of several acres in extent, which are almost virgin, but as they have very imperfect drainage, they have never received the attention they deserve.

The immediate supply of water is not large, but Rocky River and Buffalo Creek might be tapped for the requisite supply for large hydraulic operations. There are three or more veins on the property, only one of which, however, is now worked, that at a depth of 90 feet.

This vein is narrow, rising occasionally to a width of 3 feet. It is filled with quartz, extraordinarily rich in gold, and carries a small proportion of pyrite. There is an abundance of material for long-continued work, and a prosperity equal to that of the palmy days of its early history. Dr. Emmons alludes to a vein of galena on the property.*

Rocky River Mine.—This mine is in Union county, 10 miles nearly southeast from Concord, and not far distant from the Reed. It includes the Jake Shin and Tom Shin mines, consolidated. There are on this tract 7 veins, of which 3 only have been worked to any extent. These vary in width from 2 to 5 feet. The contents of the veins are quartz with iron pyrite, a trace of copper pyrite, and often sufficient galenite to affect the precious metal constituent appreciably. The ores are commonly of fair grade, and occasionally run well, but they will prove refractory in all efforts to amalgamate them.

Assays of these ores give:

GOLD ORES, ROCKY RIVER MINE, CABARRUS COUNTY.

	(163)	(164)	(165)	(166)
Gold, ounces per ton	825-1000	25-100	3 1-8	2 3-4
Silver, ounces per ton	trace.	8-10	2 83-100	5 55-100

Five shafts have been sunk, ranging from 38 to 55 feet in depth.

Gold Hill Mines.—The Gold Hill is the most noted mining district in North Carolina, and has been the most productive. It is situated 14 miles southeast from Salisbury, in the southeast part of Rowan county, and the northeastern part of Cabarrus, and overlaps slightly into Stanly county. It is nearly 1½ miles long from northeast to southwest, and ⅜ of a mile broad from northwest to southeast.

The striking characteristics of this district are the great permanency of the veins both in depth and extent, their freedom from disturbance, and the variety and richness of the ores.

The outcrop of the veins was not bold, and in some cases (the Randolph, for example), they were so obscured and covered, that they were only discovered by accident, and at a comparatively late date in the history of mining in the State—1842.

This series of mines is situated on the narrow plateau of a low-lying northeast and southwest ridge. This ridge is broken by a small gulch near the Standard mines, and by a still deeper gulch on the

* Emmons' Geology of the Midland Counties of North Carolina, 1856, pp. 166, 167.

McMakin tract, which makes the surface here quite hilly. The ridge generally slopes gently both to the southeast and to the northwest.

The mines are grouped quite closely together, and very little mineral matter is found to the west of Buffalo Creek, which skirts the ridge to the west.

This district is one mile east of the granite, and is in close contact with a diorite group to the east. The prevailing rock of the region is a chloritic argillaceous schist, the chloritic constituent being, if anything, more marked at the northeastern end, and the argillaceous at the southwestern. These schists have a strike N. 30° (and occasionally 60°) E., and a dip generally 75° to 80° W., but varying to the vertical and sometimes slightly east of the vertical.

The shoots or ore bodies have generally a northerly dip of their own in the veins, i. e., the workable bodies of ore occur alternating with relatively barren schists, and these bodies tend to the north more and more as the depth increases.

There are at least 10 well-defined veins in the district (see plate XVIII).

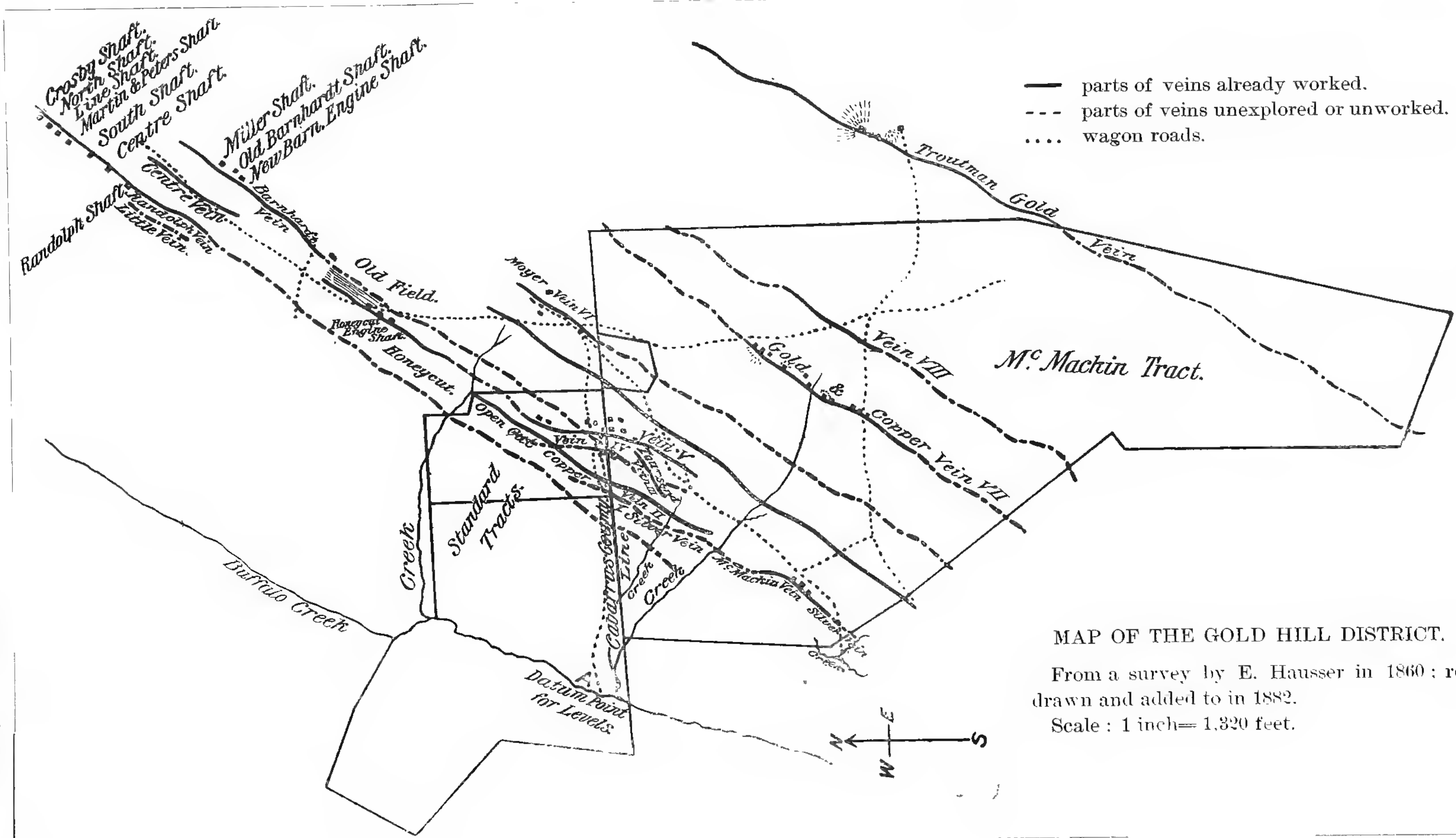
Prominent among these are the Randolph, Barnhardt, Hunnicut (Honeycut), Open Cut copper vein on the Standard property, the Trautman gold vein, and the McMakin silver vein.

But closely associated with these are outlying bodies, which may also be independent veins;—for example, the Old Field body, which is between the Barnhardt and Hunnicut veins, and is made up of several nearly parallel bodies of ore which are very narrow, varying in width from one to several inches, intercalated with the schists and very tortuous.

The Hunnicut vein has been proved for a length of 400 yards, and the Barnhardt for an equally great distance. Most of these veins conform to the strata both in strike and dip.

The Randolph Vein is nearly to the extreme northwest of the group. It has been worked for a linear distance of 1,500 feet, and to a depth of 740 feet [see plate XIX]. It is this vein which has contributed most to the celebrity of the district, and is in reality the Gold Hill Mine. The ore chimneys or shoots of this vein are especially marked. They are three in number, and extend to the lowest depth to which the mine has been worked.

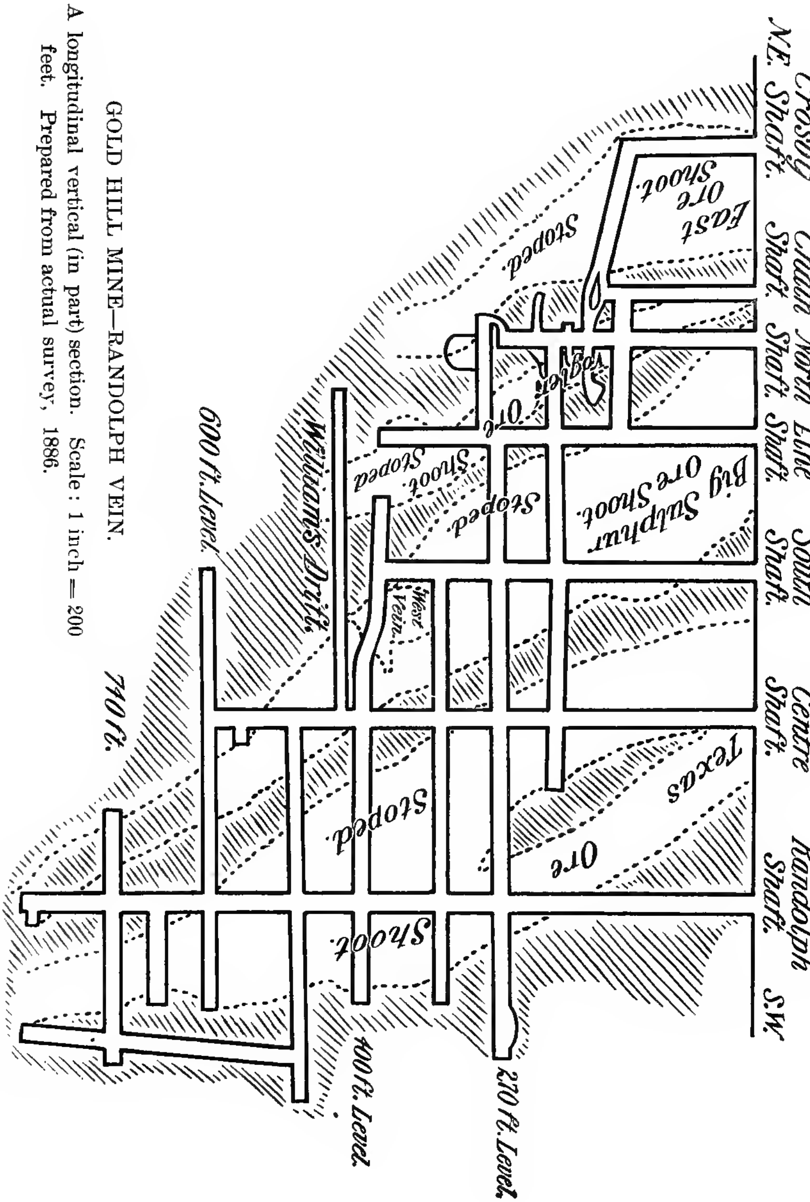
The Randoph shaft passes through the Texas shoot, just cuts the north edge of the Big Sulphur shoot, and is but a few feet distant from the Randolph shoot. The levels from the bottom of this shaft have not yet been sufficiently extended to permit a full and accurate statement



MAP OF THE GOLD HILL DISTRICT.

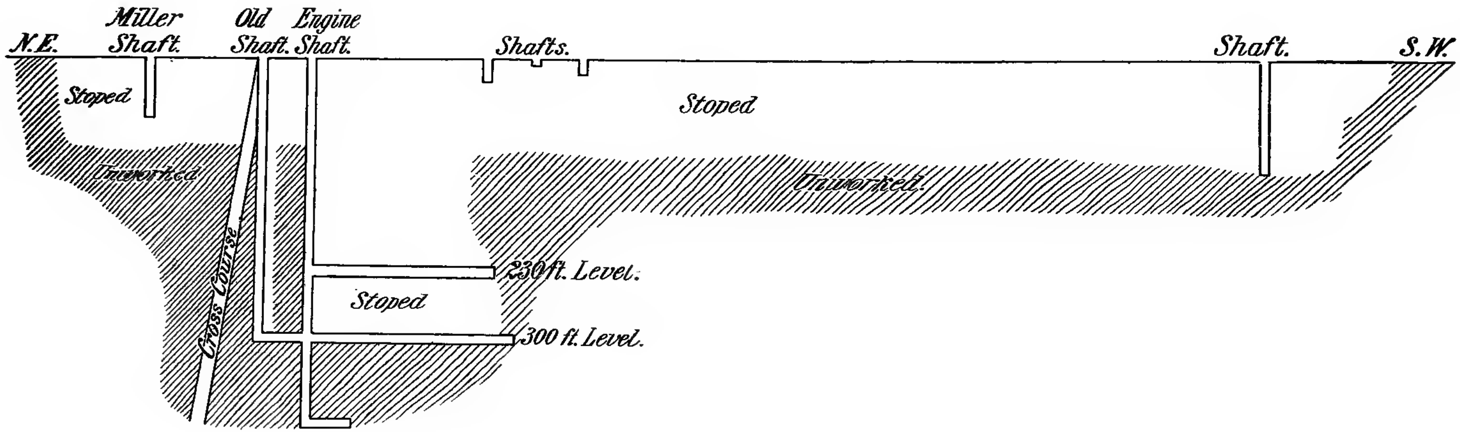
From a survey by E. Hausser in 1860: re-drawn and added to in 1882.

Scale: 1 inch = 1,320 feet.



GOLD HILL MINE—RANDOLPH VEIN.

A longitudinal vertical (in part) section. Scale: 1 inch = 200 feet. Prepared from actual survey, 1886.



GOLD HILL MINE—BARNHARDT VEIN.

A longitudinal vertical (in part) section ; drawn by Geo. Rickard, 1878. Scale : 1 inch = 200 feet.

of the amount of ore at such depths, though there cannot be much doubt but that the store is very considerable; and to this may be added a large amount of ore still left in the upper levels.

The ores are now highly sulphuretted, being mostly iron pyrite, but with enough chalco-pyrite to give a copper contents of 2 per cent. A discussion of the relation of these ores to the copper supply of the region is given in the section on Copper (page 211), and no further statement is needed here.

As respects the value of these ores it is still more difficult to speak with exactness, for the examinations have been made for the most part with reference to the plans of promoters of mines. Some statements that have been made public are unquestionably too high to be expected from steady work. It is probable that the contents will be of low grade, as compared with the ores nearer the surface. In the absence of definite information, no assays will be given, since it is not certain that the samples from which the assays were made are representative. Some indications of the range of values is given on page 212. It may be added that the sulphurets are contained in schist and quartz, and are susceptible of concentration.

The Barnhardt Vein. 400 feet east of the Randolph, has been exploited to a comparative shallow depth. Above 100 feet the linear extent of the work is as great as in the Randolph; below 100 feet the levels have been extended only about 400 feet along the vein; the ores are like those of the Randolph, but less cupriferous. In both of these veins the sulphurets are in schist with quartz, and need a preliminary concentration.

The Old Field Vein to the southwest of the main workings of the Barnhardt, and quite near to them, consist of a series of strings ("veins") of ore intercalated with the schists. These seams are frequently of great richness, but the gold "jumps" from one seam to another so often as to give some embarrassment in mining. The greatest depth here is a little more than 130 feet.

The Standard Vein and Property is still further southwest. The vein consists of several narrow belts of talco-chloritic schists charged with mineral matter, altered to gossan in the upper zone, but sulphuretted in the deeper parts. This body is very wide near the surface, but at greater depths it becomes smaller. The deepest work was 84 feet.

The Trautman Gold Vein contains the least known of the more prominent ore bodies. In this vein down to 20 feet the ores were auriferous,

porous quartz with brown ore; 20 to 60 feet down, a mixture of hematite with highly ferruginous quartz, with a little crystallized pyromorphite, cerussite and other lead minerals; lower down auriferous pyrite and quartz. Near the surface the ores were very rich in gold. This vein is almost at the extreme southeast of the group.

The McMackin Vein is the extreme southwest vein of the system, and, like the Trautman is mostly in Cabarrus county. It has been exploited by pits for several hundred yards, but the deep workings have extended over a linear distance of about 200 feet. For a further description of the mine, see section on Silver, page 192. The ores of this vein are galenites.

The Hunnicut (Honeycut) Vein is just to the southwest of the Old Field Vein, and between the Barnhardt and Randolph. It was discovered in 1842, nearly at the commencement of the mining excitement in this section, and was worked with great profit for a time, and to a depth of 185 feet.

This district has been almost entirely idle during the past 15 years, but it is probable that a well-concerted business and mining enterprise would bring back something of its old renown, and make it a very important factor in the mining development of the State. Its ores and concentrates would be a very considerable resource for smelting purposes, though not of high grade.

*Conrad Hill Mine.**—This mine is in Davidson county, about 7 miles nearly east from Lexington. The veins at their outcrop, and for a moderate depth to the east of the north and south dividing line, formerly belonged to the "Morehead Estate," while to the west of this line they belonged to other parties. And the old description and designation of "Conrad Hill" of thirty years ago apply to the former (the eastern), while latterly the name applies to the western tract.

The mine is now controlled by the Conrad Hill Gold and Copper Company of Baltimore. The hill is of very moderate elevation—less than 100 feet above the adjacent valleys—and with very gradual slopes.

The geology may be described in a few words. The Conrad Hill is one of a series of noted mines which lie along the northwest margin of the great central slate belt (Huronian or Taconic) of the Atlantic

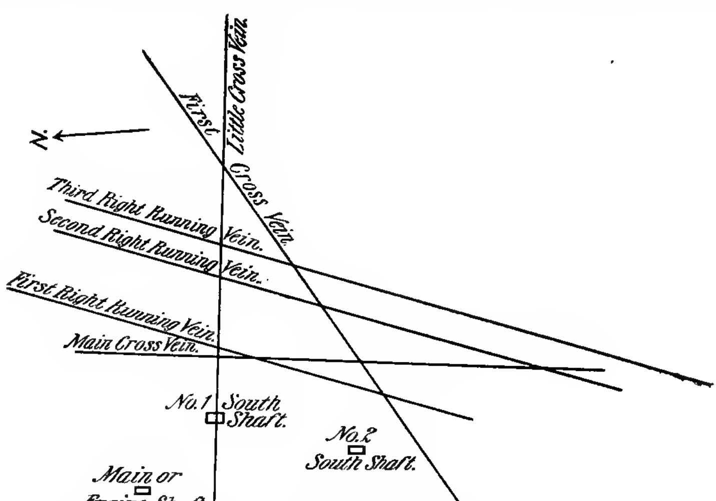
*The description here given of this mine is reprinted with slight alteration from a special report made by Prof. Kerr in May, 1881, which report was published in the Baltimore *Sun* of June 4, 1881.—J. A. H.

slope, near its line of contact with the central granitic axis of the region, the Laurentian or Mont Alban series.

The most common and characteristic rocks of this region, especially along the northwest side, are chloritic, fine-grained quartzitic, and what are called talcose slates (schists).

The Three Hat Mountain, some 3 miles south, is described by Emmons* as composed of quartzite and slaty chert, and he mentions a northeast lying trap dike, 100 yards wide, as traversing the intervening valley. The rocks of Conrad Hill are described† as "talcose slates;" but they are really fine-grained argillaceous quartzite schists, with pyrophyllitic partings,—and this is, indeed, the predominant gold-bearing rock of this whole "slate belt" These schists are thin-bedded and much jointed, and often shaly in structure. They dip to the northwest at a high angle, 80° to 90°, and have a strike at this point N. 10° to 20° E.

There are two systems of veins traversing the hill (see accompanying figure); one consists of veins parallel to each other and to the



PLAN OF VEINS AT CONRAD HILL GOLD MINE, DAVIDSON COUNTY.
Scale: about 1 inch to 300 feet. (Largely after Emmons.)

strike of the rock, while in dip they frequently, perhaps it may be said generally, cut across the strata, with a slighter, i. e., a more westerly dip.

* Geology of the Midland Counties of North Carolina, 1856, p. 143.
† The same, p. 152.

The second system of veins differs from these only in being entirely independent of each other and of the rocks, in strike and dip.

The former Prof. Emmons has designated* as *right running veins*, and the latter as *cross veins*. The gangue of both is quartz and carbonate of iron. They yield both copper and gold, the former occurring as a sulphuret (chalcopyrite), except in the upper levels, where it has suffered a partial oxidation; the latter occurring as free gold, both in the quartz and in the altered carbonate (brown oxides) of iron of the upper—and in the sulphurets of the lower levels.

Emmons describes four right running veins, which he calls "*first*," "*second*" and "*third*," or "*front*," "*middle*" and "*back*" *veins*, the fourth being considered a branch of the third. The first of these crosses near the top of the hill, striking north about 10° east, and dipping west at a high angle. The outcrop of the second or middle vein he places at the distance of fifty feet east of the first, and supposes it to be parallel in dip, as well as in strike, to the first. In this, however, he is evidently mistaken, since the two veins appear to meet within a hundred feet of the surface.

There is evidence in the old workings that still another vein, with a very steep dip, exists between the second and third. This back vein we suppose to cross the line of the South shaft at a depth of less than 130 feet. In its thickness, and in the amount and kind of matter which composes it, he considers this the most remarkable of all the veins of the hill. "It is 15 inches thick at its outcrop, and at the depth of between 60 and 70 feet it is 10 to 18 feet wide. It is quartz above, but at 50 feet carbonate of iron, carrying sulphurets of copper and iron, this part of the vein being 4 feet thick at the 90-foot level, and rich in gold."†

Emmons mentions‡ also 3 cross veins, one as having no outcrop, and only revealed in the engine shaft, and two others which he describes as among the richest of the whole hill. The first of these latter was worked to a depth of 90 feet, and seems to be the one represented as crossing the South shaft, No. 1. The other, having a strike nearly east and west, and a dip south, was worked to a depth of 60 feet, and showed a width of 4 feet of very rich ore, on which a drift of some 60 feet was run. It must, therefore, be the vein which appears on this cross course in South shaft No. 2.

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* Emmons' Geology of the Midland Counties of North Carolina, 1856, p. 145.

† The same, p. 149—quoted with slight alterations.

‡ The same, p. 145.

In addition to these there appear to be two other veins, not discovered when Emmons wrote his description—not showing themselves, apparently, on the part of the hill to which his attention was confined. One of these is a very large vein—larger than any of those above described.

The veinstone is quartz and iron carbonate, carrying copper pyrite and gold. This vein is exposed in all three of the shafts, below the point where the other veins are cut—below 100 feet. It is not clear whether this vein comes to the surface, or where it is put down on the sketch (page 269) as the *main cross vein.* The other new vein is indicated on the diagram to the west of, and parallel to the first or front vein. It has been opened by several shallow pits, and shows a four-foot quartz vein, with visible gold. An unsorted sample of the excavated mass yielded, in an assay by the company's chemist, $31 per ton for gold.

There are three shafts sunk on the property, as shown in the diagram, and as they are all in front of the right running veins, these will all be penetrated by each of them at the same depth. In No. 1 South shaft, Emmons estimated that the last of them, the back vein, would be cut at 130 feet. A large body of ore was entered at the depth of 98 feet, where, according to Captain Edward B. Wilder, the front and middle veins have united and form one mass. From this shaft, at the depth of 105 feet, a drift has been run by the present workers of the mine some 40 feet north and 90 feet south, along and in this body of ore, exposing a thickness of 5 to 10 feet, all of which "contains gold in paying quantities."

The veinstone is quartz, iron carbonate and spongy brown oxide of iron, carrying free gold and copper sulphurets and carbonate. In the lowest part of this great mass of ore, the richer portion, about 4 feet wide, separated from the remainder of the vein by a well-defined line of demarkation, will all assay high, and at places will yield $200 to $300 per ton. * * * I took samples of these across the face, for an aggregate length of 40 feet, and a thickness of 15 to 18 inches, which assayed by Hanna, yielded $94.12 per ton, for gold alone.

Just south of the shaft, a cut has been made from the drift, across this body of ore, measuring some 37 feet, to the foot wall, giving a thickness of upwards of 20 feet. A large part of this thickness is composed of crushed slates filled with strings of quartz. A sample taken across this section, which is 10 to 15 feet high, including slates,

quartz and everything representing the whole body of the vein, yielded \$22.73 per ton (Hanna). Of course by a process of selection, throwing out the poorer masses of quartz, spar and slate, the yield per ton might be doubled or increased even to a higher percentage.

Just north of the No. 1 South shaft, in the same level, is cut Emmons' second cross vein, which seems to coalesce with the bed of ore just mentioned. There is, therefore, exposed an immense mass of ore, in the mere exploitation of which, by the drifts and cross-cuts, made in the development of this part of the vein, a pile of material has been accumulated at the surface, which is estimated to contain nearly 3,000 tons of ore, of which an average sample gave Mr. Clausen \$28.60 per ton.

In No. 2 South shaft, according to Wilder, the veins cut at 67 feet represent the front and middle veins of Emmons. On this point "a cross-cut has been driven 62½ feet back and into the first and second veins, and two levels started, one each way, on the course of the first vein. Both sides of the drift are in good ore, and in the southeast side a course of gold and copper ores, varying from 18 to 24 inches in thickness, has been exposed, that will assay over \$100 per ton. Indications are that the ores here are as rich and abundant as at No. 1 South shaft." At the depth of 100 feet a drift has been carried some fifty feet south in a mass of ore, of which only the foot wall is exposed, on which lies an ore course of about 2 feet, the veinstone being quartz and brown oxide of iron, carrying gold and copper. A sample taken along this ore body gives (Hanna) \$13.39 gold per ton.

Some forty feet north of this shaft, on the same level, a similar ore course of 12 to 20 inches of prill copper (i. e. 33 per cent. copper) is exposed towards the upper part of the vein, while a stope driven up and along the middle of it, in brown oxide and iron carbonate, gives, by assay of sample representing a thickness of 3 feet, \$17.58 for gold (Hanna). This is probably Emmons' second vein. There is exposed in these two drifts a face of nearly 100 feet of ore, with three good ore courses, within a total exposed thickness of the vein of not less than ten feet, the hanging wall being nowhere in sight.

Forty or fifty feet more of drifting will connect this level with that coming south from No. 1 South shaft. Emmons' third cross vein is cut in this shaft at the depth of 57 feet, but no new excavations have been made at this level. "At a vertical depth of 103 feet from the surface this shaft cuts into, and at 122 feet passes through, the main

cross vein, proving it to be 17 feet thick at this point, and composed of quartz and carbonate of iron, with more or less yellow sulphuret of copper. The vein is underlying at 46°, and the shaft will be continued down the incline of the vein, which has been more thoroughly exposed in the main shaft." This shaft, therefore, opens four important veins, and it is within 40 feet of the new vein, which was recently discovered, and which can also be worked from this direction. The quantity of ore accessible from this point, therefore, and within a very moderate depth, is immense, and this takes no account of the back vein, which, of course, must be reached at no great depth below the present termination.

The Main or Engine shaft is situated 195 feet west of No. 1, and is distant 240 feet from No. 2 South shaft. It has been sunk 220 feet vertically.* At 163 feet the shaft passes through the main cross vein. Throughout the entire distance a rich course of copper ore is exposed from 3 to 8 feet in thickness, of which 1 to 4½ feet is solid prill ore, giving an average of not less than 2 feet. Samples taken from across the whole distance of the face of this prill, and assayed by Hanna, give $11.98 gold per ton in addition to its copper value. This ore course of prill copper is also exposed, in a thickness of not less than 5 feet, in a drift now in process of cutting northwards, at the 175 foot level.

From the preceding account, the estimate which Dr. Emmons placed on this mine is here concurred in. The exposure of the huge bodies of rich ore in the drifts and shafts are sufficient of themselves to justify this estimate.

I may add that I do not think any of the descriptions or diagrams of these ore deposits, beyond the actual depths to which explorations have been carried, can be considered as having any great value. For example, not less than three of these veins are cut in one mass at the 100 foot level in the Whim shaft No. 1, and at least two of them are changed in course and dip. The statements here made, accompanied by the sketch map showing the surface arrangement of the veins, are the best approximation now attainable.

All these veins are bold and marked in their characteristics, and all are free from dislocations or other disturbances. The ore is remarkably destitute of all distinctive iron minerals—carbonate of iron and its peroxide excepted—and even iron pyrite is rarely met with.

The general course of metallurgical treatment may be outlined as

* Subsequently to the depth of 400 feet.—G. B. H.

follows: The mine matter was partly sorted out underground, and still further hand-cobbed and picked in the sheds; the richer ore was sent at once to the copper works; the residues, after passing through a Blake Crusher, were jigged, and the best material added to the richer mine stuff above alluded to; the poorest material from the jigs was rejected, the medium grade sent at once to the stamp battery and amalgamated as usual; the tailings from the battery were partly concentrated by buddles and blankets, and the concentrates sent to the copper works.

At the outset, the richer copper minerals were, after roasting, smelted in a shaft furnace for matte, from which, after re-smelting, a black copper was obtained and refined. The material, however, was not suited to this treatment, as the necessary basic matter was lacking to make a proper flux, and smelting was superseded by the wet method under the Hunt & Douglas patent (old method), i. e., the crushed ore after roasting was subjected to a bath of protochloride of iron, for the conversion of the insoluble copper mineral into the soluble chloride; after leaching the copper was precipitated by metallic iron and refined. The residues, now mostly peroxides, were sent back to be milled and amalgamated, and, to a slight extent, concentrated again. The final products were gold bullion and refined ingot copper.

Financial derangements have brought about a cessation of mining work for the present, but during the later and prosperous years the work was carried on by careful and systematic methods.

The Ward Mine is in Davidson county, one mile west of the Delk. There are at this mine several veins—a "slate vein" of yellowish decomposed chlorite; a quartz vein 3 to 4 feet thick, and auriferous, occurs near the top of the hill; and another vein of massive quartz occurs 25 feet still further up the hill. A rich gravel, 1 to 14 feet thick, covers the surface of many acres about the mine.

There are a few mines grouped geographically in this section, but which do not readily allow themselves to be grouped geologically with those heretofore described. Among these:

The Hamilton (Bailey) Mine is in Anson county, 2 miles southeast of Wadesboro. There are here 2 veins, of which the westerly has been worked to a depth of 100 feet; the vein is reported to be $2\frac{1}{2}$ to 4 feet wide; the ore is largely quartzite (compacted into hard quartz at the depth of 100 feet), highly stained with oxide of iron. The tract comprises 114 acres, and the vein is $\frac{3}{4}$ mile long.

Assays per ton are $10.34, $17.40, $13.68 and $46.57.

The Jesse Cox Mine is in Anson county, 2 miles southeast of Wadesboro. Its ore body is quartz.

Gold Ores of the Central Syenitic Belt.

The mines of this central belt (Upper Laurentian) present so many peculiarities that, as a class, they justly claim a distinct and separate discussion. This belt has been already mentioned (pps. 238 and 239), and it is simply necessary here to point out a few of its peculiarities.

It has a width of 15 to 25 miles, running across the State in a northeast to southwest course, and has long been known as the "granite belt;" the term is so familiar that it cannot be easily displaced, but in reality there is very little granite here; mica is rare, but chlorite, hornblende, pyroxene and epidote are very abundant, and occur in the most inextricable confusion. In the space of a single hand specimen all of these minerals, together with magnetite, may often be found. Stratification is wanting, but false bedding is frequent; trap dikes are numerous and of many varieties, and in weathering occasionally assume a bedded structure. The term "syenitic belt," will be nearer the truth, but even this term is lacking in fullness and accuracy.

The mines are not uniformly distributed over this area; at the northeast in Guilford county, they occur near the southeast edge of the belt, and near the Huronian schists; this relative position they hold as far south as Rowan county, where they begin to appear at a considerably greater distance from this border; and finally in Mecklenburg county, and near the south boundary of the State, they stretch nearly across the entire granite area from east to west. It may be said with almost absolute accuracy, that the mines are on the east side of the North Carolina Railroad to a point little further south than Concord, where the mineral belt crosses the railroad abruptly and spreads to the westward.

The ores of these mines are almost always auriferous, and occasionally cupriferous; they rarely contain any considerable amount of lead, zinc or nickel; the silver present is usually alloyed with the gold; arsenic and antimony are not common, and the ores are refractory only as the sulphurets make them so.

Some general considerations respecting the mines of this belt will find a convenient introduction here: The veins are in the syenite, the fissures ranging from a few inches to 60 feet and more in width. Most of these fissures are filled with killas (slates), quartz and ore. These

slates are aluminous, talcose or chloritic in character, finely laminated, and often very fissile; they are generally parallel to the walls of the vein. The presence of these slates in a vein, sometimes in a perfectly vertical position, in a formation, where there is at best but scanty evidence of bedding, has always attracted the attention of mining engineers and geologists, and is an interesting phenomenon. The slates are generally nearer the walls, but sometimes within the quartzose material itself, and generally shade gradually into quartz toward the interior of the vein, and into the country on the outside.

In great depth the slaty structure does not exist, or becomes obscured; for an example of this structure, see the section of the McGinn vein.

In many mines there is what is called a back and a front vein (occasionally a middle vein also), but the evidence goes to show that they are merely seams of the same vein.

The quartz frequently shows a tendency towards lamination, especially near the walls, and when broken out, even seemingly massive quartz shatters into somewhat schistose fragments. There is generally a parallelism in the occurrence of the sulphurets, but it is not as evident as in some other constituents of the vein.

The student of physical geology will readily understand that the surface of the entire country has been subjected to extensive transformation, the most marked of which are the peroxidation of the iron constituents and a disintegration of the rocks to a great depth. It is no unusual thing to find such alterations at a depth of 150 feet.* The absence of ordinary glacial action in this region has permitted the surface to remain largely in position. (See Appendix A.)

The permanent level of the water in the mines is, perhaps, a little below that of the running streams adjacent, and is found at from 20 to 60 feet below the surface—40 or 50 being the more common depth. The amount of water about the mines is usually large, and it is not unfrequent that the larger part of the expense of mine administration lies in the cost of pumping.

The upper part of the vein has undergone a corresponding change, in which much of the slaty part has been oxidized, and softened ("rotted"), and the iron pyrite is for the most part changed to a hematite more or less hydrated (brown ore); the copper pyrite, etc., has

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* In 1872, I examined a mud-slide which cut the Randolph vein at the Gold Hill Mine at a depth of 500 feet. It was a very soft, plastic clay, thoroughly peroxidized.—G. B. H.

become malachite (rarely azurite), chrysocolla, and occasionally either black or red oxide of copper, or else the copper constituents have disappeared. The brown ore holds not only the gold, which was originally in the sulphurets, but it has been further enriched as a result of the alterations which have taken place, as is evidenced by the presence of nuggets and grain gold, which are always found in this zone far more abundantly than in the deeper ores. Ores of this class are not difficult to work, and require little and inexpensive machinery. The treatment is rather a mechanical process than a metallurgical one, and with close attention to the process, a large part of the precious contents are extracted at a small cost.

At the water line the sulphides appear with relatively little alteration, and the value of the ores is considerably diminished since the causes of enrichment have been less active than in the gossan portions near the surface.

The cost of mining is at this stage largely increased, chiefly as it becomes necessary to use pumping and other machinery, the purchase and keeping in order of which are heavy expenses. A much greater obstacle is, however, met in the difficulty of extracting the gold by the simple methods of amalgamation hitherto satisfactory.

The increased expense attending the work in every part, and the simultaneous decreased yield, brought about the abandonment of the greater part of the mines in North Carolina, shortly after reaching this stage, and they still remain in this condition.

In some cases the ore bodies actually disappear in this zone, through the closing in of the syenite walls ("pinching out of the ore body").*

Very few of the mines become settled and regular above 200 feet; below this depth the slates are for the most part wanting, or less evident, and there is a marked tendency for the sulphurets to concentrate

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* This "pinching" or "squeezing out" is a very common term applied to the deep work of most of the mines, and in some cases is a fact, but in other cases within my observation, it is only temporary, and there is a clue in the shape of a narrow seam or thread of ore to guide to other and equally large bodies. The presence of the "blue rock" or "blue granite," which causes the pinching (see page 209 for analyses) seem to point to some geological phenomena not yet well-understood, which unfavorably affected the ore deposits for a time. It may be incidentally added that the "granite" sometimes bends the ore seam out of its normal course and dip, though the vein fissure itself may continue nearly the same.—G. B. H.

and form large and valuable chimneys.* Otherwise the sulphurets are scattered in a gangue of quartz, which forms for the most part the filling of the vein. Peroxidation is not frequent or extensive below this depth, but native gold is often found attached to the sulphurets, and a simple concentration of these ores will generally disclose a surprising amount of gold in a free shape.

The group of mines in Guilford county is not large. A dozen names make up the list of the prominent ones:

The Fisher Hill and Willis Hill Mine is 5 miles south of Greensboro.

The Hodgins Hill is one mile north of the above.

The North Carolina, or Fentress, is 2 miles northeast of the Fisher Hill.

The Gardner Hill is 3 miles northeast of Jamestown.

The Twin Mine is 6 miles south of Greensboro.

The North State (McCullough) is 2 miles south of Jamestown.

The Lindsay is the south extension of the North State.

The Jack's Hill is the north extension of the North State.

The Deep River is 2 miles south of the Lindsay.

The Beason, Harland and Beard Mines are near Jamestown.

Most of these are copper bearing, and were fully described by Emmons, and as they have not been worked since his day, need no further description, if, indeed, there were material for it; a brief condensation was taken from Emmons, as a matter of convenience, and given in the section on Copper (p. 205, *et seq.*), and to these pages the reader is referred.

The Fisher Hill and Willis Hill Mine was not described in the section on Copper and may here be noticed briefly. There are 15 veins on this mining tract. One system of veins runs approximately north and south, and a second series nearly northeast by southwest. The mining work at present is done on Fisher Hill, and on Willis Hill, 150 rods nearly south, and apparently on a vein (or veins) of the first system. This vein is very flat, so that at the nominal depth of the inclined shaft (180 feet), the ore is still within the reach of oxidizing influences. The mine material is brown ore, with relatively little sulphurets, which latter are a white iron pyrite, with a very little copper pyrite. The aggregate length of the veins on this property is perhaps not less than

* They sometimes contain ore fully as rich as any that the gossan furnished.—G. B. H.

8 or 10 miles, though not everywhere worked, or capable of being worked under existing conditions. The particular vein worked is traceable for nearly a mile, and has been successfully operated at several points. The ore body varies from 10 inches to four feet in width and carries a relatively high grade milling material—$30 per ton as claimed; 4 levels, aggregating nearly 200 feet, have been run.

The work on Willis Hill consists of four shafts of much shallower depths than those on Fisher Hill. Here at the moderate depth of 50 feet a good body of brown ore was found. The milling plant consists of 10 stamps, and very effective work was done in 1886.

Thomasville, in Davidson county, is the centre of an interesting mining district, several mines occuring in the granite in its vicinity. Of these only the Lalor, Eureka and Black have acquired much reputation through actual work, and none of them are now operated.

The Lalor (formerly Allen) Mine is in Davidson county, 2 miles southeast from Thomasville. It is entered by 3 shafts, the deepest of which reached a depth of 165 feet on the underlay. The vein is reported of good width, and carries a fair proportion of iron and of copper pyrite. The proportion of copper pyrite is large enough to give, when concentrated, a product very desirable for matte smelting. The lowest grade brown ore is reported to assay $20 per ton, and the highest grade sulphuret $190.

The Loftin Mine, in Davidson county, is one and a half miles southeast of Thomasville. Its vein stuff is quite similar to that of the Lalor Mine.

The Eureka Mine is one-half mile west of the Lalor. It is penetrated to a depth of 125 feet. The width and character of the vein and the nature of the ore are nearly the same as at the Lalor Mine.

The following assays represent the character of the ores, Nos. (168), (172) and (173) more correctly representing their common average:

GOLD ORES, EUREKA MINE, DAVIDSON COUNTY.

	(167)	(168)	(169)	(170)	(171)	(172)	(173)
Gold, ozs. per ton	1 6-10	35-100	3 1-2	2	2 1-4	95-100	1 1-10
Silver, ozs. per ton	1 12-100	82-100	1 7-100	1-8	trace.	2 18-100	2 23-100

Thomasville has been the seat of a vast amount of speculative mining, and even of some frauds; as a consequence, legitimate work has been discouraged, and the promising mines of the neighborhood have not received their just dues.

There is an approximation to belts in the occurrence of the mines of Rowan county.

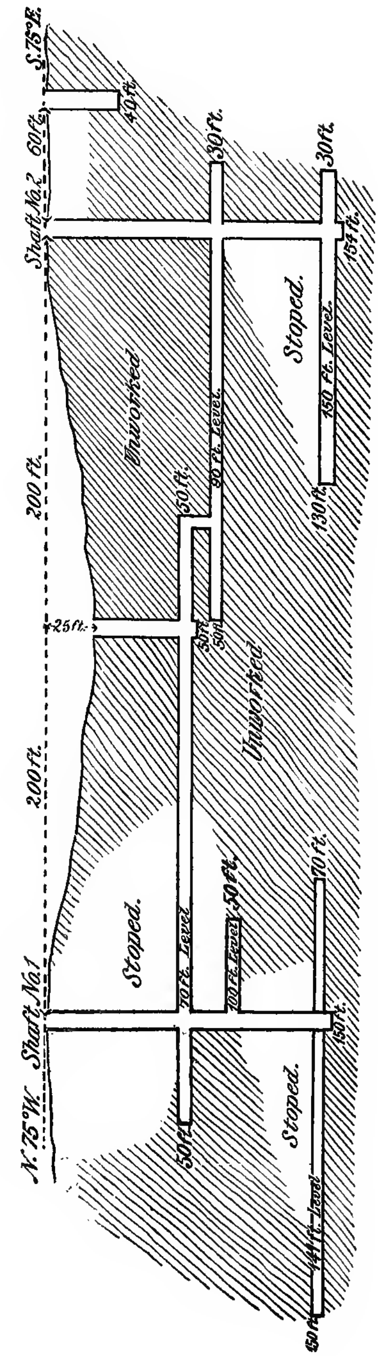
One of these belts is found to the southwest of Salisbury, from 2 to 9 miles distant, and 1 to 3 miles to the east of the North Carolina Railroad. Among the mines of this belt are the Hartman, Yadkin, Negus, Harrison, Hill, Southern Belle, Goodman, Randleman and Roseman. The workings in these have been comparatively shallow, 120 feet being the deepest, so far as the records go. It is probable that some of these may prove valuable, but the width of the ore bodies and their values are not matters of record, and nothing can be said of them here with exactness.

A second belt occurs 2½ miles east to southeast from Salisbury, prominent among the mines of which are the Dunn Mountain, the New Discovery, the Reimer, and the Bullion. The former are found on the western side of the Rowan granite range (Dunn's Mountain range), and the latter on the southeast side.

The mines of Rowan county, situated in the Gold Hill District (in the "slate belt") have been previously described; the dividing line between the slates and the granite is about one mile west of Gold Hill.

It may be well here to call attention to the large number of veins in the southeastern part of Rowan county, and the adjacent parts of Stanly and Cabarrus. A good map of this section of Rowan county has been prepared by the Rev. Dr. Rumple and Messrs. T. K. Bruner and J. J. Newman, of Salisbury, which, together with the data prepared by Mr. Bruner, shows more than a hundred mineral localities in this portion of Rowan, and as many more in the neighboring parts of Stanly and Cabarrus counties. Of most of these we know but little, as the surface of the country is so rugged as to make exploration difficult, but there is little doubt that these hidden stores will some day play an important part in the developed resources of the State.

The mineral veins of the region are of fair width, persistent in length, and, as far as tested, in depth also. They all carry sulphurets, usually iron pyrite, but, as a rule, since the exhaustion of the surface deposits, treatment by amalgamation has been a failure, as the sulphurets have proved too refractory to yield their auriferous contents to this mode of treatment; and such concentration as has been hitherto available has left an insufficient margin of profit to justify the effort. Cheaper mining, better management, more thorough concentration and less costly metallurgical treatment will, without doubt, put an entirely new face



REIMER MINE.

A longitudinal vertical section ; November, 1882. Scale : 1 inch = 100 feet.

on the matter. It is only fair to add, that the mines have been held at too high prices.

The mines of Rowan county which have been most largely worked, are the Yadkin, the Dunn's Mountain, Reimer, Bullion, New Discovery, Dutch Creek, Gold Knob, the Atlas and Bame.

The Yadkin (Tuck) Mine is one and one-half miles south of Salisbury.

The Dunn's Mountain Mine is four miles southeast of Salisbury, a little to the left of Gold Hill Road, and on the west flank of Dunn's Mountain. It has had a very chequered history—now worked vigorously and now idle. Nothing whatever is done on the mine at the time of writing this report.

There are 3 veins—one northeast and southwest, one northwest and southeast, and one nearly north and south (Office Shaft vein). The first of these veins is worked to a depth of 190 feet, averaging about four feet in width. It was most largely filled with slate and quartz, and carried only a moderate proportion of iron pyrite with a trace of copper pyrite.

The Office Shaft vein was worked to a nominal depth of 160 feet (about 140 feet vertically), 90 feet being in the vertical shaft, and 70 on an incline of about 45°. The ores were peroxidized nearly to the lowest depth reached, and free milling. The amount of sulphates present was small. In the lower levels the ore body was broken up into several seams.

The outcome of the operations was not satisfactory, and this with litigation caused the final abandonment of the work.

*The Reimer (Rymer) Mine.**—This mine is in Rowan county, 5 miles southeast of Salisbury. The course of the vein is approximately N. 75° W., and its dip slightly southward, but not far from the vertical; the vein varies in width from 4 to 8 feet, and occasionally to 12 feet. It was worked some thirty years ago for the brown ore, but the poorer part of it was left standing as pillars until a few years ago. The unaltered ore was a dark colored pyrrhotite, with a very slight amount of copper, and assayed very moderately. The ore shoot was 700 feet long in the direction of the vein extending from shaft No. 1 to shaft No. 2, and having a westerly pitch of its own in the vein. At the extreme west of the bottom level it had pitched entirely under the work; the

* Emmons' Report on the Geology of the Midland Counties of North Carolina, 1856, p. 181.

ore showed a considerable tendency to lamination, and left very clean walls.

The Yadkin Chlorination works near Salisbury were supplied for several years from this shoot; the ore was concentrated at the mine for that purpose, 5 tons raw ore being generally required to make 1 ton of concentrates, approximating $40 per ton in value. The work of the mine was terminated in 1883 by the burning of the buildings and destruction of the machinery.

The Bullion Mine is ½ mile eastward of the Reimer and is a continuation of the same lode as the latter. The character of the lode is similar to that of the Reimer. The outcrop shows that the vein is of good width, but for some unknown reason it has never been much worked.

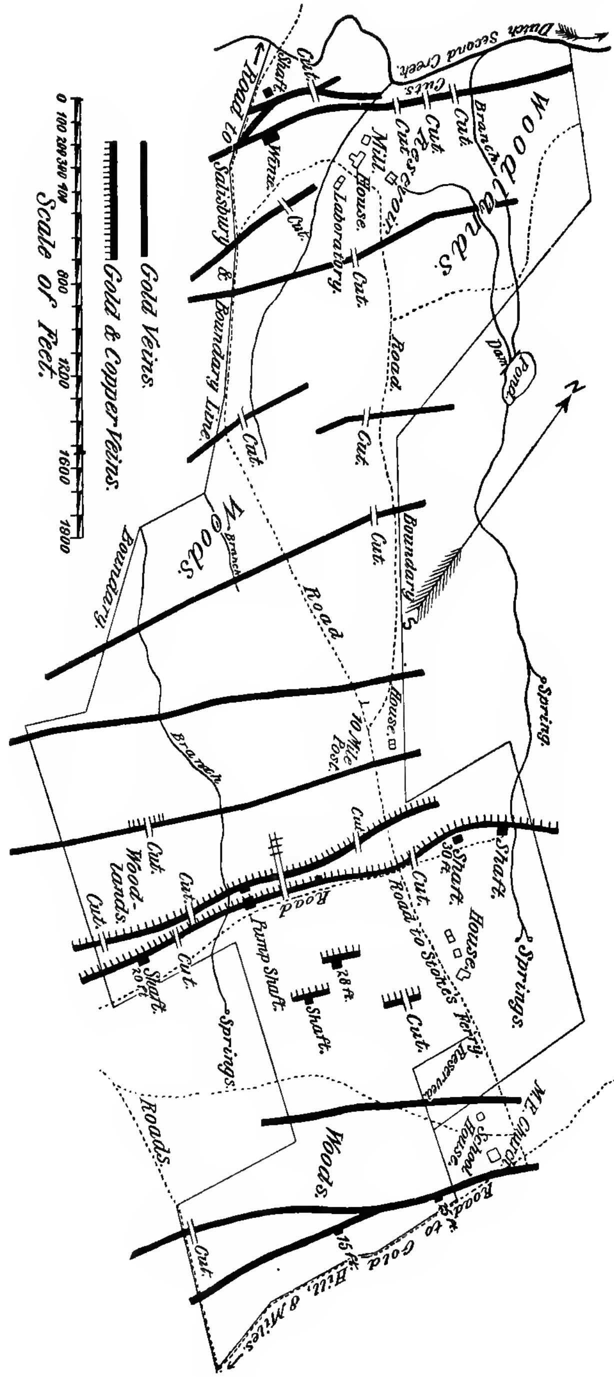
The next belt of mines is found 8 to 10 miles east from Salisbury, and is not far from, and on both sides of, the Stokes Ferry road. Among these may be named the Howard, the Barringer, Gold Knob (and its associate the Holtshauser), Davidson & Wilson, Dutch Creek, Morgan, Kistler and Atlas. The more easterly of these veins lie about 1 mile west of the contact between the granite and the Huronian schists.

The Gold Knob Mine is 9 miles southeast from Salisbury on the Stokes Ferry road. This group of properties is made up of several mining tracts, and has not less than 11 veins. The more important of these have a general northeast course, and an eastward dip of from 70° to 75°. Three only have been recently worked: the Haynes, the Gold Knob, 40 rods northeast, and the Holtshauser, some 20 rods still further southeast. The Gold Knob is the larger, being in places some 20 feet wide. The ores are similar to those of the district, and are commonly of only moderate value; the sulphuretted ores are susceptible of easy concentration, as is shown by the assays given below. The Haynes vein is also wide and easily traceable for a long distance. The ores are brown ores, and sulphurets of a like tenor. The Holtshauser is of good width, but not so wide as the second vein; the ores are of the same character as those of the second vein.

GOLD KNOB MINE, ROWAN COUNTY.

ASSAYS OF GOLD ORES (174–78) AND CONCENTRATES (179 & 180).

	(174)	(175)	(176)	(177)	(178)	(179)	(180)
Gold, ozs. per ton	95-100	1	2	1-2	....	1 2-10	5 1-10
Silver, ozs. per ton	95-100	9-10	8-10	trace.	....	1 65-100	2 85-100



MAP OF THE DUTCH CREEK MINING TRACT.

Prepared by J. J. Newman, 1883. The tract contains 161 acres.

Dutch Creek Mines.—These are on the Stokes Ferry road, 10 miles southeast from Salisbury, and just to the southeast of Dutch Second Creek, as shown on the accompanying plate (XXII)*. The property of 161 acres is a net work of veins. It is estimated that there are 20, of which several carry copper as well as gold. The veins chiefly developed are the Katie, Hill, Tip-top and the Spring.

The Hill and Tip-top have 2 shafts down to water level, and levels aggregating several hundred feet in length. The ores above the water level are the common brown ores, which are always free milling, and generally good. Below this line they are highly sulphuretted and refractory to mill treatment, and with a contents of $10 per ton and upward. The veins vary in width from 1 to 18 feet, where the two veins cross.

Several shafts on the Spring vein, down to water level, also expose brown ores changing downward to pyrites with some copper. Two shafts were sunk on the Katie vein with like results.

The copper vein has a shaft 50 feet deep, in which a vein was disclosed carrying fine copper ore. The vein dips eastward some 75°; the foot wall is siliceous schist (sandstone), and the hanging wall talcose schist. Another gold and copper vein about 50 yards to the west, dips about 45° eastward.

Most of these veins run in a general northeast and southwest direction, but some seem to have a more northerly course, and intersect the normal running veins.

It has been stated that these veins are about 1 mile west of the contact of the granite and the Huronian schist, which appears to be near Reedy Creek. This line of contact is, however, rarely well-defined.

Atlas and Bame Mines.—These mines are supposed to be the southwest continuation of the Dutch Creek Mines. This property, of 1,600 acres, also abounds in veins, running N. 35° to 40° E., and with a nearly vertical dip. Some of the veins are wide, but the ore, as a rule, is rather low in grade, and below the point where they are no longer free-milling, they are difficult to treat.

The next group of mines is some 2 to 3 miles further east, and topographically appears to be the northeast continuation of the Gold Hill

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* The accompanying map (plate XXII) was prepared for this Report by the owner of the Dutch Creek Mines, Mr. J. J. Newman, in 1883, at the request of Professor Kerr.—G. B. H.

group, which is only 3 to 4 miles southwest; but of the geological connection we cannot be quite assured. None of the mines of this group are now worked, and none are well known. The Survey has been able to obtain no information as to their depth, size, or the amount and character of their ores. However, the general appearance of the outcrops seems to indicate veins of good width, with a fair supply of low grade ore, running into refractory sulphurets at greater depths.

There appears also to be in the southeast part of the county a line of mines extending from the Barringer Mine, Stanly county, through Rowan county, and crossing the Yadkin River, passing into Davidson county. Galenite is occasionally found in this region, as on the farm of J. W. Miller, near Stokes' ferry, which is nearly in the same horizon as the Silver Hill Mine, 15 miles northeast. None of these have as yet been developed. Their description belongs more properly to the pages on the "slate belt," but is introduced here for convenience.

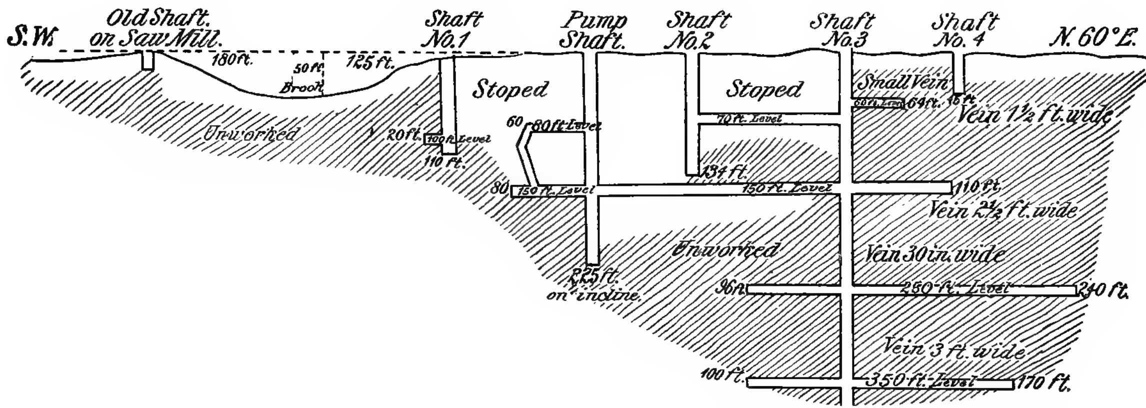
The mines of Cabarrus are for the most part to the east of the North Carolina Rail Road; 57 localities are enumerated by T. K. Bruner as having been worked, earlier or later; the larger part of these, however, now exist only in name. Probably some of them, though obscure, are valuable.

The mines of Cabarrus in the "slate belt" have been described already (see page 264). In the granite region there is only one mine in operation, viz., the Phœnix, though it is only recently that the Tucker (California) and the Quaker City were also worked.

The Quaker City Mine, the last of the three just mentioned, is 5 miles a little south of east from Concord. There are 3 shafts on the property, 40, 60 and 80 feet deep, respectively. The vein is 2 feet wide, and carries in its lower depths rather heavy iron pyrite with a little copper, and is troublesome to treat.

The Tucker Mine is 8 miles southeast of Concord, and is about one-third mile west of the junction of the granite and the "slates." At the time of the death of the superintendent (at which time the mine was permanently closed), the main shaft had reached a depth of nearly 100 feet, and levels had been driven 81 feet south and 36 feet north. The vein was 18 to 30 inches wide, its strike northeast and southwest, and its dip nearly vertical. The ore was heavy sulphuret (including a little copper pyrite), with heavy spar.

Phœnix Mine.—This mine has been worked more extensively and for



PHŒNIX MINE.

A longitudinal vertical (in part) section, from surveys by A. Thies, 1882. Scale: 1 inch = 200 feet. Shaft No. 2 is vertical; all other shafts are inclined at an angle of about 80 degrees from the horizon.

a longer period than any other mine in Cabarrus county, and in 1886 its works had reached a depth of 350 feet on the underlay; the vein runs nearly northeast and southwest, and dips very slightly to the west, (see plate XXIII).* In the upper levels the vein had a comby structure; in the lower, it was stringy and scattered. The greater part of the uderground work has been done in the north end of the vein, where the ore proved more satisfactory; not much stoping has been done under the 250 foot level. In the lower levels the south end of the vein ranged from 3 to 4 feet, with an ore seam approximating 2 feet; in the north level it was 24 to 30 inches wide, with an ore seam of 20 inches. The filling of the vein is quartz, but barite is of frequent occurrence; the ore is iron pyrite with a little copper pyrite.

The ore is cobbed and sorted, the heavy sulphurets (1st class) being treated to themselves; the other portion (2d class) being stamped and concentrated. The assays from this mine give the following:

GOLD ORES, PHŒNIX MINE, CABARRUS COUNTY.

	1ST CLASS ORE.	2D CLASS ORES (182–'85).			
	(181)	(182)	(183)	(184)	(185)
Gold, ozs. per ton	3 2-10	4-10	4-10	6-10	8-10
Silver, ozs. per ton	1	trace.	trace.	trace.	35-100

The method followed here is chlorination, and a very complete plant has gradually been arranged for that purpose. The method appears to be very successful, and a high percentage of the gold (90 to 95 per ct.) is extracted, at an expense not exceeding $8 per ton of ore. The whole establishment is a model of skillful and successful adaptation of familiar methods.

Gold is probably more widely diffused in Mecklenburg county than in any other county of the central part of the State. As heretofore stated, the productive area extends from the east edge of the granite and syenite formation to its extreme western edge, instead of being confined to its eastern half, as in the more northern part of this belt. In this area of 30 by 20 miles are well nigh 100 mines,† which have at some time or other been worked profitably.

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* This map, together with most of the data, have been furnished by the Superintendent of the mine, A. Theis.

† The term "mine" is not here used in the sense of "claims" or "allotments" of a few feet, but rather in the sense of entire veins, most of them having a length of several hundred feet each.—G. B. H.

The general consideration given on pages 275–'78 will explain the circumstances under which they were worked, and why so many have been abandoned. About a dozen of these mines are now worked, but only 2 or 3 with any vigor.

The great number of these localities forbid a full description of each. Only those at work, or which are considered the more important, can be described in the limited space of this report. To a great extent they are capable of being grouped into smaller districts—into neighborhoods preëminently mineral.

The vicinity of Charlotte is one of these mineral districts, and around it on all sides are mines, among them the following: Davidson, Blake, Point, Parks, Clark, St. Catherine, Rudisil, Smith & Palmer, McDonald, F. Wilson, Howell, Trotter, Carson, Taylor, Icenhour (Icyhour), and some others unknown to the general public, or unnamed.

A second group is found 5 to 10 miles west and northwest of Charlotte, embracing the Hayes, McGee, Brawley, Frazer, Hipp, Campbell, Todd, Arlington, Capps, McGinn, Stephen Wilson, Trautman, Prim, Abernathy, Alexander (Chapman), Dunn, Sloan, McCorkle, Cathey, with several others too inconspicuous to mention.

A third group is found around the Ferris (Faires) 6 miles north of Charlotte.

Still another group is found in Providence township, and about Sardis church, some 5 to 10 miles southeast and east of Charlotte; among others the Hunter Mine (2 veins), Tredinick and Ray (3 veins).

The Pioneer Mills group of mines in Cabarrus county extends into the northeast part of Mecklenburg. Most of these mines have been already mentioned; others are the Johnson, Stinson, Maxwell, Black and Harris.

Other mines on the extreme eastern edge of the county are in the "slate belt," and do not need to be noticed here.

The description of these localities will in certain respects follow the groups above outlined, though most of the mines of the county have the same general characteristics.

Davidson Hill Mines.—Davidson Hill, 1 mile west of Charlotte, has 3 mines, covering a ridge ½ mile long. The south end or the Davidson mine proper has been worked to a depth of 80 feet; the vein was 3 to 4 feet wide, and the ores were reputed good.

The Point Mine, at the north end, is now operated to a depth of 160 feet. The various levels have opened up sufficiently large bodies of

ore to keep a 10-stamp mill employed during the greater part of the time. The peroxidized ores extend much deeper in this mine than is usual in this region.

Rudisil Mine.—The Rudisil and the St. Catherine mines are respectively in the south and the north part of the same vein; the former is one mile, and the latter one-half mile south of Charlotte. They have been worked to greater depths than any other mines of this belt. The bodies of ore in both mines, nearer the surface, lie in slates,* which approximate in places to a hundred feet in thickness. These slates are both argillaceous and chloritic, and everywhere siliceous, and are frequently replaced by layers of quartz with ore. They are generally finely laminated, and for the most part regular in thickness.

At the depth of 200 feet or more the slaty character becomes less evident, and ultimately to a great extent disappears and seems to give place to the country rock. The country varies considerably, and presents several lithological problems that cannot be discusssed here. The rock of both walls is crystalline, and generally syenite and massive, but in places somewhat chloritic and schistose in structure.

The strike of the vein approximates N. 30° E.; the dip is northwesterly, nearly 45°.

At the outset, and to the depth of something more than 100 feet, 2 bodies of ore (or "veins") were recognized—the "back vein" and the "front vein," but the intervening mass of slate frequently carried subordinate bodies of ore ("veins"). The two ore bodies (front and back "veins") vary considerably in width—from 2 to 4, and sometimes 6 feet. There seemed to be a tendency for these to come together as they descend, and at the depth of 200 feet the vein appeared more consolidated.

The ore was carried in pockets in the slates (or schists), and in great abundance, so that for many years the mine was very prosperous. At the surface, and to a considerable depth, the mine material was the rich and easily treated brown ore of the region.

The zone below water level carried iron pyrite with a little copper pyrite; and the ore was scattered somewhat through a slaty and quartzose gangue, being less "pockety" than that above the water line. The

* Emmons' Geology of the Midland Counties of North Carolina, 1856, p. 176.

assays for this zone as a rule showed material of only moderate value. At the 200 foot level the peroxides have mostly disappeared, and with them largely the free gold, though both are present in some proportion to the lowest level—350 feet below the surface (See plate No. XXIV.) At greater depths the sulphurets were scattered thinly through a quartzose and somewhat slaty gangue, or in narrow seams, or concentrates in large, wide and rich shoots of nearly solid sulphurets. An inspection of the plate will show the position of these shoots—3 in number. As regards the northern shoot neither the point of origin nor its character are matters of record; it is not known above the 130 foot level.

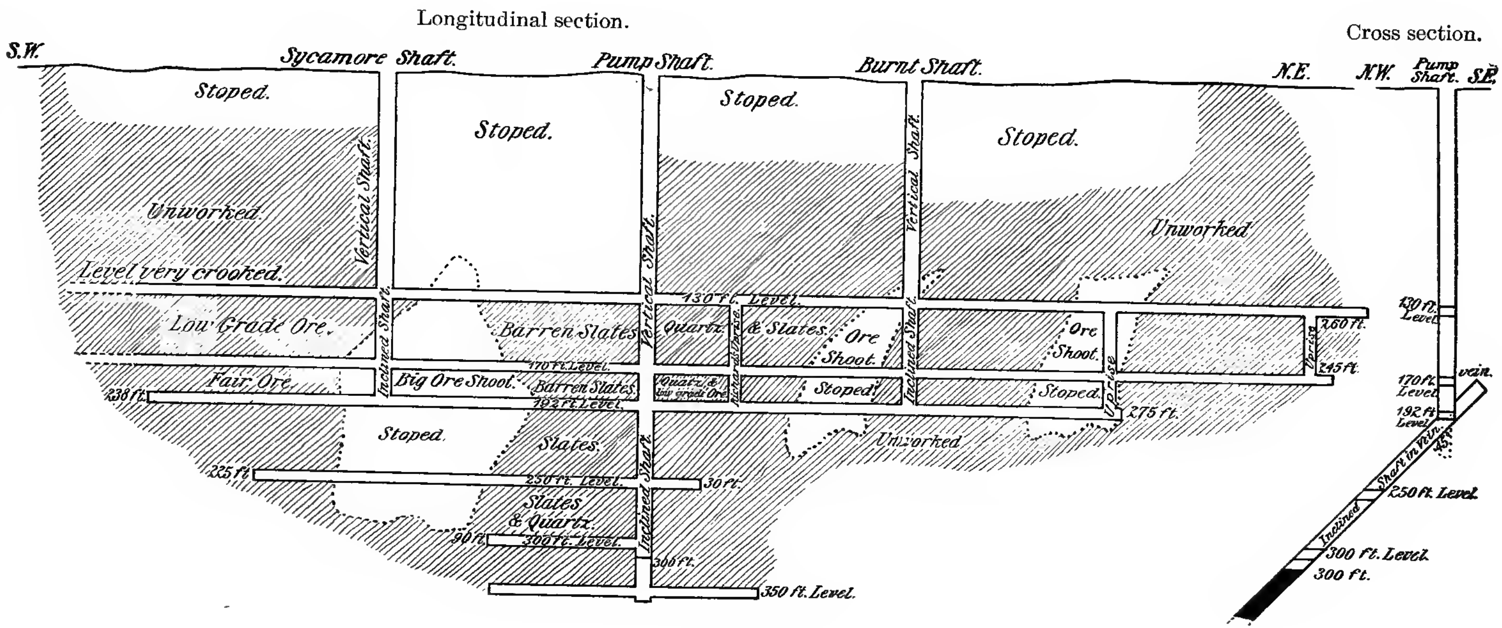
The south and the middle ("Burnt Shaft") shoots began just above the 130 foot level in narrow threads, and expanded both in width and in length at greater depths. Neither the north nor the middle shoots have been followed below the 192 foot level to any extent, though slightly explored from the 250 foot level. The north shoot increased from a mere seam to 5 feet in thickness, and had a length in the direction of the vein, varying from 30 to 50 feet. The material of this shoot was a high grade sulphuret, but not the best that the mine has furnished. The middle shoot increased in the same way to be 8 feet thick, extending longitudinally from 10 to 50 feet; the grade of ore is believed to have been somewhat higher than that of the north shoot.

It was, however, to the Big shoot (South shoot) that the mine has in recent years owed its reputation. It commenced like the middle shoot almost in a point, and gradually widened and lengthened with a slight south pitch of its own in the vein, till it became in places 15 feet thick, and 100 feet long; its ends were not abruptly marked off from the adjacent vein or from the "country," but passed gradually into mine material comparatively barren, or into "country" quite worthless.

The contents of the shoots, as a whole, were compact iron pyrite with a very little copper pyrite, and some quartz, which latter was, however, for the most part readily cobbed out. This ore was uniformly of high grade, entire shipments sometimes ranging as high as $180 per ton. (See assays Nos. 196, 197, 198).

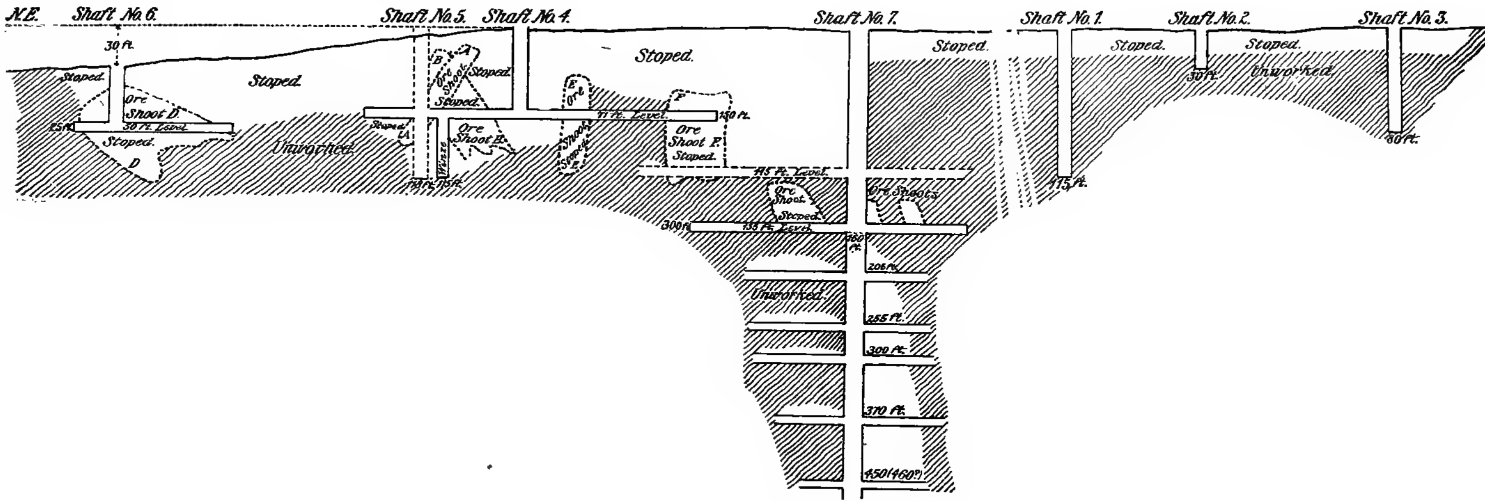
This shoot extended down a little below the 300 foot level, but in the 350 foot level it has never been found. There has been much speculation about it, and opinions have varied as to whether it had disappeared altogether, or was simply "thrown" from its normal position by one of the many deflections of the vein from its direct course.

It may be added in conclusion, that the so-called barren parts of the



RUDISIL MINE.

Vertical (in part) longitudinal and cross-sections, drawn from the notes of Wm. Jenkins and Wm. I. Smart, 1883. Scale : 1 inch = 110 feet. The black color in the lower portion of the cross section indicates the unworked portion of the vein.



ST. CATHERINE MINE.

A longitudinal vertical (in part) section, drawn from the notes of Messrs. G. W. Pitcher and Wm. Lewis, 1883. Scale : 1 inch = 150 feet. The ore shoot A is found on the foot wall and dips northward ; shoot B is found in the hanging wall and dips southward ; shoots E & F probably dip southward, but have not been explored sufficiently to permit of a positive statement. Shaft No. 5 is considerably in front of No. 4, and does not enter either the level or vein. The distance between shafts 1 and 7 is 1,300 feet. The section runs N. E. by S. W.

vein bear pyrites scattered through the quartz or slate, or carried in seams, and most of it is quite capable of being treated, in the present condition of the ore market, by a preliminary cobbing, which separates the massive pyrites for a smelting treatment, and at the same time prepares the lowest grade material for battery amalgamation, and subsequent concentration. This mode will be spoken of in more detail under the head of the St. Catherine Mine.

The following assays show the character of the material from this mine:

ASSAYS OF ORE, TAILINGS, &C., RUDISIL MINE, MECKLENBURG COUNTY.

	(186)	(187)	(188)	(189)	(190)	(191)	(192)
Gold, ozs. per ton	2 1-5	1 45-100	1	1 7-10	3 1-4	2 9-10	45-100
Silver, ozs. per ton	trace.	15-100	1-10	5-10	88-100	1 34-100	1 93-100
	(193)	(194)	(195)	(196)	(197)	(198)	(199)
Gold, ozs. per ton	1 7-10	1 2-10	2 6-10	11	8	6 1-10	6-10
Silver, ozs. per ton	74-100	trace.	2 1-4	1 32-100	35-100	73-100	trace.
	(200)	(201)	(202	(203)	(204)	(205)	(206)
Gold, ozs. per ton	3-10	3 6-10	4	1 3-4	1 5-10	1 34-100	3 1-2
Silver, ozs. per ton	trace.	trace.	trace.	1-10	trace.	trace.	trace.

Assays Nos. 188, 192, 199 and 200, represent pyrites scattered in its gangue.

Assays Nos. 187, 189, 193, 194, 203, 204, 205, represent second class ore.

Assays Nos. 186, 201, 206, represent low first class ore.

Assays Nos. 196, 197, 198, represent first class cobbed sulphurets.

Assays Nos. 190, 191, 195, represent concentrated tailings.

St. Catherine Mine.—This mine is located in the northeast extension of the Rudisil lode, the two points operated being ½ mile apart. The region intervening between the two mines has been more or less prospected, but as yet nothing of much importance has been found (in the comparatively superficial work done), which promised well for deeper operations. Both mines have the same general features, and agree in course and dip.

The St. Catherine (formerly the Charlotte) is somewhat deeper than the Rudisil, having reached the depth of 460 feet (155 feet vertical, and 305 underlay—equivalent to a vertical depth of 370 feet). Plate No. XX V shows the important points to be noted in underground works. The shallower deposits resemble those of the Rudisil. More care has

been taken in locating and mapping the bodies of ore in this part of the mine than in the lower portions, as will be seen by reference to the plate. Below the 255 foot level, the surveys have not yet been coördinated, and no attempt has been made to give more than an outline sketch of the lowest underground works.

In the lower depth the vein does not seem to be well consolidated, and the geology is very perplexing. The dike (or what is so-called) in the country of the hanging wall has disturbed the deposits. No large chimneys of solid high grade ore have been found below 250 feet, but there are below this point several very large shoots of low grade ore quite suitable for milling and concentrating, notably the ore body worked from the pump shaft and between the depths of 200 and 370 feet, below which point it has not yet been removed. This body had the extraordinary width of from 4 to more than 60 feet. The occurrence may be briefly stated as a series of obscurely parallel seams of slate, between which are bodies of ore 2 to 6 feet in thickness, more or less mixed with quartz. A like occurrence on the 450 foot level is also worthy of mention, and this fact has led even experienced mining engineers to regard the vein as a bedded one.

At the depth of 275 feet the foot wall begins to fall back to the eastward from its normal position, and at the depth of 370 feet it is found fully 68 feet further back (to the eastward) of the position it would have occupied had its regular course been maintained. At the same point from which the foot wall began to recede, the ore body abruptly turned from its course of 45° horizontally westward, and so continued for some distance, when it began to curve gradually downward. Its relations with the lower bodies have not yet been established. Some bodies of ore on the 450 foot level lie so far in advance (westward) of the foot wall as to suggest a connection.

It is much to be regretted that the surveys and details of the lower work are not collated sufficiently to allow of a careful discussion, but it is impossible at the present time to give more than very general statements.

The cross vein (N. W. and S. E. vein) has been examined from the 155 foot level for a distance along the vein of 100 feet. The ores were found to be not so good as those of the main vein.

Reserves sufficient for 2 years' work are at command, and the policy of the manager, Mr. G. W. Pitcher, has been at all times to keep well ahead of present needs. The method of treatment is by battery, amal-

gamation, etc., and concentration of the sulphurets; and the work is carefully arranged with reference to that end, by a preliminary cobbing, which separates out the massive pyrites (A) and lean ore (B—material for the stamp battery, or other mill); the free gold (C) is caught in the battery, or on plates in the customary mode of amalgamation, and the tailings led directly to the concentrating apparatus (Frue Vanners); and the fine pyrites (with a little unamalgamable gold) are concentrated out (D). The final products are:

A, cobbed pyrites for smelting; C, gold; and D, pyrites concentrated for smelting.

The proportion of A to the whole material mined (except when near a rich chimney) is very small—probably not more than 2 or 3 per cent. In the common run of mining and milling practice it requires 10 to 15 tons of ordinary quartz to make 1 ton of concentrates, which may ordinarily contain from 80 to 90 per cent of sulphurets. It is worthy of remark that the concentrates, however high the per cent. of sulphurets, rarely contain as much gold per ton as cobbed ore of the same richness in sulphurets. The variation in values of the cobbed ores and sulphurets is very considerable.

The following assays will show the range in character and value of the ores of this mine:

GOLD ORES, ST. CATHERINE MINE, MECKLENBURG COUNTY.

	(207)	(208)	(209)	(210)
Gold, ounces per ton	1 3-10	1 9-10	2 3-4	5
Silver, ounces per ton	55-100	9-20	3-10	68-100

	(211)	(212)	(213)	(214)	(215)
Gold, ounces per ton	1 2-10	1 7-10	1 6-10	1 7-10	2 525-1000
Silver, ounces per ton	1-8	88-100	trace.	22-100	43-100

	(216)	(217)	(218)	(219)	(220)
Gold, ounces per ton	3 6-10	2 6-10	4 6-10	5 1-4	8 775-1000
Silver, ounces per ton	3-10	trace.	32-100	trace.	trace.

	(221)	(222)	(223)
Gold, ounces per ton	1 95-100	3 2-10	6 45-100
Silver, ounces per ton	85-100	95-100	95-100

Assays Nos. 207, 208, 209 and 210, above, are of the brown ore.

Assay No. 211 indicates the value of the quartz with disseminated pyrites.

Assays Nos. 212, 213 and 214 are of second first class ore.

Assays Nos. 215, 216 and 217 are of low first class ore.

Assays Nos. 218, 219 and 220 are of cobbed first class ore.

Assays Nos. 221, 222 and 223 are of concentrates.

The Clark Mine.—The Clark Mine is in Mecklenburg county, 2½ miles west of Charlotte. There appear to be 2 vein systems here, one lying approximately northeast and southwest, and the other (and the last worked) nearly east and west, both with a steep dip southward. The northeast and southwest system was worked to a depth of 70 feet and from the line of pits the inference is reasonable that it must have been worked along the line of the vein for a distance of about 1,200 feet. It is alleged that this part of the mine was abandoned on account of flooding by water.

Assays of the ore from this vein give the following results:

GOLD ORES, N. E. AND S. W. VEIN (224–226), AND E. AND W. VEIN (227), CLARK MINE.

	(224)	(225)	(226)	(227)
Gold, ounces per ton	1-4	1 1-2	7 1-10	80-100
Silver, ounces per ton	trace.	94-100	22-100	trace.

The second vein system alluded to was worked to a depth of 78 feet in 1885, but the results were not satisfactory. In the 72 foot level; three bodies of low grade brown ore (in slate or in quartz) were found within a space of a little less than 25 feet, which measured respectively, 2 feet 4 inches, 7 feet, and 7 to 12 inches; this last ore body ("vein") was the only one rich enough to work, a strictly average sample of its ore giving $16.56 per ton. Too little work was done to ascertain the values of the other ore bodies. The assays were not large (see assay No. 227 above) but from analogies elsewhere it is not unreasonable to suppose that they might improve to furnish fair working material.

The Parks Mine is 1 mile northeast of Charlotte. In its working no great depth has been attained; the ore body is well reputed.

The Smith and Palmer Mine, 1 mile south of Charlotte, is in the Rudisil neighborhood. It is a mooted point whether the vein be an extension of the Rudisil, or a parallel body. Its strike in N. 30° E., and the dip about 50° westerly. A line of pits indicates vein matter for something more than 500 feet; the deepest shaft yet sunk is about 75 feet deep; the known width of the vein is 2 to 4 feet.

Assays of the ore give the following results:

GOLD ORE, SMITH AND PALMER MINE, MECKLENBURG COUNTY.

	(228)	(229)	(230)	(231)	(232)
Gold, ounces per ton	1-4	3-4	3-4	1-4	7 2-10
Silver, ounces per ton	trace.	trace.	2-10	3-10	7-10

Two other veins in the neighborhood deserve mention in this connection, the Frank Wilson and the McDonald; the former has hardly been touched; the latter has been worked to a moderate depth, but no record of the work has been preserved; both properties are thought well of.

The Howell Mine is believed to be in the south extension of the Rudisil; it has been worked to a depth of 32 feet, and something more than 50 feet of levels have been driven. The vein is 2 to 4 feet wide. The brown ores assay $5.64 to $13.78 per ton, and the sulphurets $38.53 to $77.06.

The Taylor Mine is 3 miles southwest of Charlotte, and the *Icenhour* (Icyhour) is still further in the same direction. Each of these has been worked for a distance of about 400 feet along the vein, and to a very moderate depth. Their ores are quartzose and cellular brown ores, of good grade.

The Trotter Mine is 3 miles southwest of Charlotte, and its vein is cut by the Air Line (Charlotte and Atlanta) railroad. It has been prospected nearly 450 feet in length, and worked 70 feet in depth; it has given some fine bodies of rich ores.

Of the mines of the second group mentioned on page 286 only a part have been the scene of any marked activity, but the whole neighborhood has a high reputation.

The Brawley Mine, 4 miles west of Charlotte, has been a very deceptive one. Its surface has been very productive, and the quantity of rich "float" quartz has been quite large, but all efforts to find a vein have proved abortive; the work thus far done there would indicate that the surface is a net work of quartz seams, as at the Parker or the Shuford Hill mines.

The Frazer Mine has been sunk to a depth of about 100 feet; the vein is 1 to 3 feet wide and the ores good.

The Todd Mine, 1 mile southwest of the above, has 2, and possibly 3, veins. The vein on which the greater part of the work has thus far been done is nearly an east and west vein, with a dip southward of 45°. This vein has been penetrated to a depth of 80 feet, and explored by levels. The north and south vein had been but slightly examined at the time of this writing. The ores of these veins are brown ores, quartz and sulphurets.

The Arlington Mine is 6 miles west of Charlotte. It was worked to a

depth of a little more than 100 feet in 1883, but the result was far from satisfactory. The outcrop is very prominent and large, but very poor, and the bodies of ore opened up in depth were not regarded as favorable. The merits of the mine, such as they were, were obscured for purposes of stock speculation, and the operations ended disastrously.

The Stephen Wilson Mine is in Mecklenburg county, 9 miles west of Charlotte. It has 10 well-defined veins, on a tract of 340 acres. Of these only two have been worked—the veins known as No. 2 and No. 3. Both of these have a strike nearly east and west, and dip southward,—No. 2 from 26° to 45°, and No. 3 a little more steeply. No. 2 vein is from 2 to 3 feet wide; it was entered by an underlay shaft to a depth (on the incline) of 400 feet, and 4 levels run. The mine material consisted of brown ores, iron and copper pyrite. Some very rich ores have been mined. Assays of the ores give the following results:

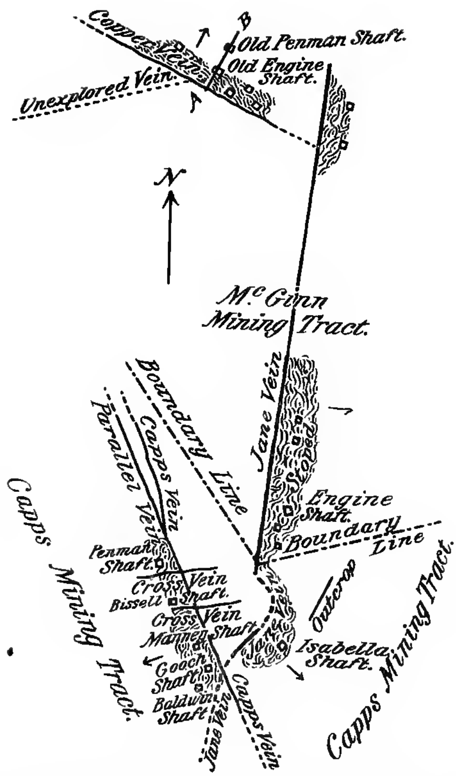
GOLD ORES, STEPHEN WILSON MINE, MECKLENBURG COUNTY.

	(233)	(234)	(235)	(236)	(237)	(238)
Gold, ozs. per ton	2 478-1000	4-100	1 2-10	4 6-10	7 50-100	16 675-1000
Silver, ozs. per ton	68-100	20-100	7-10	1 9-10	1 2-100	1

The Capps Mine.—This mine is in Mecklenburg county, 5½ miles northwest from Charlotte, between the Rozzel's Ferry and the Beattie's Ford roads. It is one of a group of veins closely united, of which two are covergent [the Jane (McGinn gold vein) and the Capps.] By the accident of different ownerships, they have been for the most part separately and differently developed. The Capps vein has a strike N. 30° to 35° W., and a dip westerly, with some variations, of about 40°. The Jane vein runs N. 40° to N. 60° E., and has a very steep pitch eastward. It is not certain that the actual intersection of these veins has been found. The Capps vein has an ascertained length of nearly 3,000 feet, and the Jane probably fully as much.

As the development of these two veins has been separate, the description will follow the course of the work.

The sketch on the next page shows the relative position of the veins, properties, shafts, and worked areas. It shows also the position and relations of the McGinn Copper vein already described (page 209).



CAPPS AND M'GINN MINING TRACTS, MECKLENBURG COUNTY.
[Scale: 1 inch to 75 rods.]

The later work on the Capps has been restricted, and finally stopped, from legal considerations, but the earlier work extended very nearly along the line of the outcrop of the entire vein—2,000 to 3,000 feet—and was carried to such depths as to disclose clearly the character of the outcrop; at points where the ore proved to be exceptionally abundant and valuable, operations were extended much deeper. There is perhaps no vein in the whole section which shows such extensive prospecting on the surface, and bears all the appearance of having been highly remunerative.

It is much to be regretted that there are such scanty records of the earlier work, and of the characteristics of the veins and deposits; the outcrop of the vein at many points still shows a width of 20 to 25 feet, and the debris everywhere indicates a very wide vein.

The ores near the surface are the customary soft peroxidized ores

(brown ores) of the section, with quartz, and are generally free-milling; the ore was not uniformly disseminated in the quartz, but generally occurred in layers, sometimes near the hanging wall, sometimes near the foot wall. At greater depths sulphurets of iron (and to a small extent, of copper), together with quartz, are found; nevertheless, at the depth of 130 feet there is still much brown ore.

The work has never yet been prosecuted to any great depth,—at the Gooch shaft 70 feet, at the Bissell 130, and at the Penman 65 feet.

The filling of this vein is quartz; its width is not known, for no systematic work has ever been undertaken to find the walls; it cannot be less than 20 feet, and possibly is considerably more.

The separation of the veins from the walls is not always sharp and definite, and occasionally, where what was supposed to be the hanging wall had been reached, another and valuable parallel body of ore is found still further beyond, which ultimately comes back to the main vein.

There are also "cross courses," which may prove to be veins, leading into the main vein nearly at right angles. One of the most conspicuous and valuable of these is found in the 130 foot level, at the distance of 225 feet southeast of the Bissell, and about one-half way between the Bissell and Manney shafts. It received temporarily the name of the "East and West vein," for want of certain data as to its relations to the main vein. This body departs abruptly from the main vein easterly and towards the Jane vein, and has been followed in that course 120 feet, and almost every foot of the vein material was ore. The width of this deposit could not have been much less than 18 to 24 inches, and the ore was of more than average value.

A few feet further north there is a similar cross-course or body of ore, but so far as explored it was not so valuable as the "East and West vein."

The Capps Mine has been noted for the amount of ore it could furnish, and for the superior grade of its ore. There are four well known bodies of ore. The first of these is near the Gooch shaft, toward the south end of the mine, and from the 78 foot level downward; it yields largely brown ore with some sulphurets, and seems to improve in character going south.

The second body is in the 78 foot level from the Manney shaft; not much can be said with precision respecting the value of this ore, though

the upper part of the body toward the surface yielded an ore of high value.

A third and very large ore body was worked out through the Bissell shaft to the depth of 90 feet. The entire length of this level is 300 feet, of which 200 feet are to the north, and 100 feet to the south of the shaft; the whole of this distance is ore, free-milling to a great extent above, but more and more sulphuretted below; it has never yet been extirely extracted above the 90 foot level, but the best part of it has been stoped out. Below the 90 foot level the ore has not been stoped out at all, except as it was necessary to remove it in running the levels. The body has been explored by a few winzes run downward toward the 130 foot level. Its connection with the large body developed in the 130 foot level has not yet been established conclusively, but there seemed to be little doubt from its position and character that there is such a connection. This body in the 130 foot level is found at a point 125 feet south of the Bissell shaft, and extends north as far as the work has been prosecuted. The shoot cannot be less than 200 feet long, and judging from the 90 foot level, it may be 300 feet. The assays of ore from it are as follows:

GOLD ORES, THIRD ORE BODY, CAPPS MINE, MECKLENBUG COUNTY.

	(239)	(240)	(241)	(242)	(243)	(244)
Gold, ozs. per ton.......	1 1-4	867-1000	567-1000	3-4	2 4-10	6 4-10
Silver, ozs. per ton.....	1-10	107-1000	trace.	1-4	3-4	65-100

Assay No. 240 is a strict average of a large body of ore from this level.

A fourth body is found in the bottom of the Penman shaft, 335 feet north of the Bissell. The stopings north of the inclined shaft are very extensive and reach to its bottom; the ore body could not have been less than 3 feet thick on an average, and rose in one place to be 8 feet; a very little good ore is still to be seen at the bottom.

The deposit in this part of the mine is comparatively shallow, and is, and will remain for some time, free-milling. The facts recited will justify the expectation of large and valuable bodies of ore at still greater depths.

That part of the Jane vein on the Capps mining tract was worked in part from the Isabella shaft to a depth of 160 feet. There is no record of the value of the ore body at this point; common report speaks well of it, but admits the refractory character of the ore.

McGinn Mine.—The sketch map given above (page 295) shows on the McGinn mining tract three veins, of which one has never been explored, the second is the Jane vein, and the third is the "copper vein," already described (see page 209 and plate XXVI).

The Jane vein has been worked from various points, and especially from the Engine shaft (150 feet) at which point all of the readily accessible ore bodies above the 150 foot level have been extracted.

The appearance and relations of the veins and of the ore bodies are shown in the sections on plate XXVI.* A glance at this plate will show an ore body not much less than 35 feet wide at points, and at the same time will disclose in the clearest manner some of the characteristics of the vein structure, which are common to this and to other mines.

The following assays show the quality of the ore:

GOLD ORES, MCGINN MINE, MECKLENBURG COUNTY.

	(245)	(246)	(247)	(248)	(249)	(250)	(251)
Gold, ozs. per ton	1-4	525-1000	1-10	1 3-8	1 1-8	4 8-10	5 5-10
Silver, ozs. per ton	1 35-100	1 28-100	93-100	23-100	23-100	55-100	6-10
Copper, per cent.		4.55	8.05				

The Cathey Mine has been alluded to under the head of copper (page 209).

The Alexander or Chapman Mine is 8 miles northwest of Charlotte, near the Rozzel's Ferry road. It has been worked to a depth of 65 feet, and levels run about 75 feet both to the north and the south. The filling of the veins is quartz, everywhere charged with brown ore, and in the lower works with sulphurets and kidney ore. The vein varies in width from 2 to 6 feet. Assays of the ore give the following:

GOLD ORES, ALEXANDER MINE, MECKLENBURG COUNTY.

	(252)	(253)	(254)	(255)	(256)
Gold, ozs. per ton	2-10	1	1 7-10	1 15-100	1 1-10
Silver, ozs. per ton	....	trace.	57-100	85-100	1

The Dunn Mine is in Mecklenburg county, 2 miles further northwest from the Alexander mine toward Rozzel's ferry, and is on the west side of Long creek. It was the first mine discovered in the county, and not

*I am under obligations to E. Motz, a former superintendent, for these drawings. —G. B. H.

long after the finding of the nuggets at the Reed Mine in Cabarrus county. Curious stories are current in the neighborhood of the ignoble uses to which these nuggets were put before their character and value were determined. The "East vein" was the first to be mined, but the ore soon changed to copper pyrites, which, though auriferous, proved to be too refractory to be treated by the methods then in vogue, and the vein was abandoned after working to a depth of 20 feet. Above this point the ores were mostly peroxidized. This vein is 6 to 12 inches wide; its course is nearly north and south, and its dip west.

The deposit which has been most largely worked is known as the Main vein—a body of slates bearing northeast and southwest, and dipping southeast at an angle of nearly 45°. This body of slates extends across the property for a distance of ¼ mile along its outcrop. It contains bodies of quartz and brown ores (including a very hard red hematite, more nearly resembling specular iron), cellular quartzose ores, and a compact pyrites, including some copper pyrite. Another "vein" is found 50 feet back of this, but the sections indicate that the whole is one body, with a front and a back seam of ore, and not properly two veins. The appearance at the 60 foot level, where three bodies of ore are seen within a few feet of each other, gives strength to this view, that they are subordinate seams of the same vein, and makes it a not unreasonable supposition that they may combine in depth to form one ore body. The contents of these top ores is shown in assays Nos. 257 to 260, below.

The underground work consists of a shaft 60 feet deep, and a second shaft of 90 feet, which is considerably to the east of the veins; a level has been driven from the bottom of this shaft to meet the veins, but has not intersected them at the time of this writing. The 60 foot shaft is connected with the 90 foot shaft by a level (the 60 foot level) across the formation. Three if not four parallel bodies of ore are cut across by this level. These bodies are composed of quartzitic slates, varying from 3 to 5 feet each in thickness, and with an aggregate thickness of not less than 12 feet. No drifting had been done on these parallel bodies, and their character and strength is not known; nor had any sampling or assaying been done when this mine was examined, as the ore bodies had just been cut by the underground works, but they appeared to be of fair grade and value. Should this character and strength of the ore bodies be maintained, there can be no doubt of a large amount of ore at command for the constant work of the 10-stamp battery.

The following assays (Nos. 257–60) are of ores from the upper portions of the mine. Assay No. 261 represents the sulphurets:

GOLD ORES, DUNN MINE, MECKLENBURG COUNTY.

	(257)	(258)	(259)	(260)	(261)
Gold, ounces per ton	1-2	2-5	1 4-10	6 214-1000	1 266-1000
Silver, ounces per ton	trace.	trace.	1 5-10	trace.	trace.

Henderson Mine.—This mine is in Mecklenburg county, 7 miles northeast from Charlotte. The new shaft has reached a depth of 90 feet, and three bodies of ore have been prospected from it. The longitudinal extent of these bodies has not yet been ascertained; they vary in width from $1\frac{1}{2}$ to 4 feet. In the lower works, the sulphurets, more or less altered, is the mine material, but the brown ores have not yet disappeared. The assays have shown the ores to be of good grade, as follows:

GOLD ORES, HENDERSON MINE, MECKLENBURG COUNTY.

	(262)	(263)	(264)	(265)
Gold, ounces per ton	675-1000	2 6-10	3 1-10	3 1-2
Silver, ounces per ton	38-100	15-100	55-100	48-100

The Ferris (*Faires*) *Mine.*—This is located in Mecklenburg county, 6 miles north of Charlotte. There are two veins on this tract, and a third on an adjoining tract, which has been worked in connection with this tract, and held with it, practically. The two veins first mentioned are believed to unite toward the south, and to form the third vein alluded to.

The "North" vein has been worked most extensively; little is now known of the "South" vein, which is 300 to 400 feet southwest of the former. The strike of this vein is N. 25° W., and its dip about 45° southward; the vein is 2 to 7 feet wide, and has a pay seam varying in width from 18 inches to 4 feet. Neither the geology nor the lithology differs much from that of other veins of this section. The rich brown ores of the upper levels give place to sulphurets, which, at the depth of the 90 foot level, are quite compact. The mine carries rather

more copper pyrites than is usual in such mines. The following assays show the character and value of the ores:

FERRIS MINE, MECKLENBURG COUNTY.

	BROWN ORES (266–70).				
	(266)	(267)	(268)	(269)	(270)
Gold, ounces per ton	65-100	1 95-100	5 4-10	6 1-10	1 4-10
Silver, ounces per ton	2 17-100	3 65-100	trace.	1 99-100	trace.

	SULPHURETS (271–74).			
	(271)	(272)	(273)	(274)
Gold, ounces per ton	9-10	3 1-2	1 95-100	24 5-10
Silver, ounces per ton	1 4-10	trace.	3 65-100	5 82-100
Copper, per ct. per ton	14.23	......	13.66	......

The Henderson tract vein (Vein No 3) shows a large outcrop, but the ore is not so promising as that on the adjoining Ferris tract. Assays of ore give the following:

GOLD ORE, HENDERSON TRACT VEIN, MECKLENBURG COUNTY.

	GOSSAN.	KIDNEY ORE.
	(275)	(276)
Gold, ounces per ton	1-4	2 6-10
Silver, ounces per ton	trace.	trace.

Other mines in this group are the Alexander, northwest of the Ferris, the Nolan and the Caldwell.

The Hunter group of mines is 5 miles southeast from Charlotte, and near Sardis church. There are here two well-known veins, and outcroppings of several others. There is no record of the amount of work done in either, nor of the extent of the ore bodies. Recent explorations show a small amount of ore still accessible, which assays as follows:

GOLD ORES, HUNTER MINES, MECKLENBURG COUNTY.

	(277)	(278)	(279)
Gold, ounces per ton	1	1 1-10	2 15-100
Silver, ounces per ton	trace.	trace.	13-100

The Trediwick Mine is 7 miles southeast from Charlotte. It has been prospected to a depth of 80 feet, and for a length of 200 to 300 feet. The vein is 1 to 2 feet wide, and carries a relatively large amount of copper minerals.

Baltimore and North Carolina Mining Company's Mine.—This property is located in Mecklenburg county, 9 to 9½ miles southeast from Charlotte, and within one mile of Mathews. It comprises 360 acres of land, on which there are five veins, with an aggregate length of about 4 miles. The south vein has been worked to a depth of 60 feet, and the Phifer Grove vein to a depth of 40 feet. The mine material from both was free milling brown ore.

The Ray vein, the best known of them all, is entered by 6 shafts; the north shaft is 200 feet deep; the 150 foot level has been driven 95 feet north, and the 200 foot level, at the time of this writing, has just been started. The ore seam is 6 to 8 inches thick, and is filled with nearly compact sulphurets. Most of the ore, down to the 120 foot level, has been stoped out. The levels from the southernmost shaft uncovered a large and fine body of auriferous chalcopyrite, a mineral which seems to be very generally present throughout the sulphurets, but is concentrated in the southern part of the vein. The following assays show the value of the ore from this vein:

GOLD ORE, RAY VEIN, BALTIMORE AND N. C. MINING CO.'S MINE.

	(277)	(278)	(279)
Gold, ounces per ton	1	1 1-2	10 8-10
Silver, ounces per ton	1-4	3-4	3

There are other mines in Mecklenburg county that do not readily lend themselves to any grouping. Of such the following may be given:

The Simpson Mine, in Clear Creek township, in Mecklenburg county, 10 miles southeast of Charlotte, has several veins, which yield quartzose ores with little sulphurets.

The Black Mine, 10 miles east of Charlotte, has a small but very rich vein of the finest variety of brown ore, assaying as follows:

BROWN ORE, BLACK MINE, MECKLENBURG COUNTY.

	(280)	(281)	(282)
Gold, ounces per ton	2 4-10	2 7-10	11 4-10
Silver, ounces per ton	50-100	95-100	8-10

The Johnson, Stinson and Rhea Mines are east and southeast of Charlotte, from 7 to 9 miles distant. Too little is known of these mines to warrant any exact description here.

The Maxwell Mine is in the same neighborhood as the above; the vein has been worked to a depth of 75 feet, and has a width of 1 to 6 feet; the ores are iron pyrites, in large masses.

The Harris Mine is 10 miles nearly east from Charlotte. The stretch of mining property on which this mine is situated is known to have some rich gravel. Surface Hill, one of these localities, is famous for its rich nuggets, and occasional pockets of ore of extreme richness are found there. The great difficulty in treating this locality lies in the absence of a large supply of water.

On the farm of the Elliotte Brothers, 5 miles south of Charlotte, there are several veins, but they have never been prospected to any great extent. Rich auriferous chalcopyrite is found at several points.

On the farm of A. H. Hunter, at Huntersville, 16 miles north of Charlotte, is a gold vein with a promising exposure. It has been explored to a depth of 23 feet, and found to carry some good ore.

The mines of Gaston county are for the most part in the gneissoid formation, which extends, with the exception of a few narrow belts, to the extreme western boundary of the State.

The Oliver Mine, in this county, is 12 miles northwest of Charlotte, and on the west side of the Catawba River. It is believed to have been among the earliest worked mines in the section, and there are traditions of work here which was done prior to the Revolutionary war. It has been worked for a distance of 100 yards, and yields in its upper levels brown ores and cellular quartz; at the depth of 75 feet, the sulphurets appear in some quantity, and notably galenite, when the ores are always richer in gold.

The Farrar Mine is ½ mile beyond the Oliver.

The Rhyne Mine is 17 miles west of Charlotte.

The Derr Mine is in the same neighborhood as the Rhyne.

The Rhodes Mine is in Gaston county, 18 miles southwest of Charlotte; it has been worked to a depth of 100 feet, and for a length of 300. The mine is peculiar, in that the gold is found not in a vein, but in a bed of ferruginous, decomposed, schistose micaceous gneiss. Galenite is occasionally found in the bed.

The Duffie Mine, Gaston county, is 16 miles west from Charlotte, on the Tuckasegee Road. The vein is from 2 to 10 feet wide, and has been worked to a depth of 110 feet, at which depth a very large body

of sulphurets was found, but it was relatively of low grade. Assays of the ore give the following:

GOLD ORES, DUFFIE MINE, GASTON COUNTY.

	(283)	(284)	(285)	(286)	(287)	(288)	(289)
Gold, ozs. per ton..........	2-10	65-100	238-1000	6-10	1-4	8-10	1-2
Silver, ozs. per ton........	trace.	50-100	1 98-100	51-100	58-100	45-100	7-10

The Robinson Mine adjoins the Duffie, and the ore is of a like character.

The Smith Mine is 13 miles west of Charlotte, and the *Sam Beattie* just to the south of the Smith.

The Long Creek property has 3 veins—the Long Creek, Dixon and Asbury; the latter of which had extraordinarily rich shoots of ore, but the common run of ore, like that of other mines, is of relatively low grade, as shown by most of the assays below:

GOLD ORES, LONG CREEK PROPERTY, GASTON COUNTY.

	(290)	(291)	(292)	(293)	(294)	(295	(296)
Gold, ounces per ton...	8-10	2-10	3-4	1-2	1 1-20	3	4
Silver, ounces per ton........	trace.	trace.	trace.	trace.	22-100	3-4	1 1-10
Sulphur, per cent	8.49	30.22	....	....	....	....	....
Sulphide of iron, per cent...	....	....	....	....	41.7	57.6	....

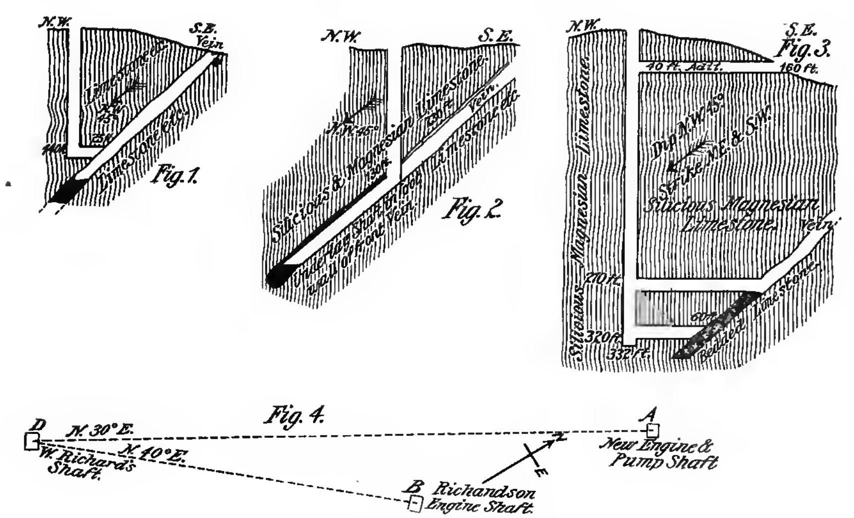
The Asbury vein is 6 to 8 feet wide. It carries blende galenite (in depth), mispickel, iron and copper pyrite, carbonate of bismuth, etc.

The Burrell Wells Mine is 3½ miles south of the Duffie. There are here 4 veins, the deepest work on which is less than 50 feet. There is still considerable placer gold on this property.

McLean's (*Rumfeldts*) *Mine*, in Gaston county, is 15 to 16 miles southwest from Charlotte. It has been prospected probably for a length of 200 yards, and for a depth of 110 feet; the vein is 1 to 6 feet wide; the ores are quartz, brown ore and iron pyrite.

Catawba (*or King's Mountain*) *Mine.*—This mine is in Gaston county, 1½ miles nearly south of King's Mountain station, on the Atlanta and Charlotte Air-Line Railroad. It is in the limestone belt, which forms so prominent a feature of the geology of this section (see page 156). It was discovered in 1834, and worked in a small way for some 30 years, when the present form of machinery was introduced. The gold was first discovered in a branch, and in working up the branch to the source of the gold the vein was uncovered. It was about 3 feet thick,

and contained sugary and cellular quartz, with brown ore. Much of this gossan outcrop was too poor to work with profit, and was left till quite lately for treatment. At greater depth the ore body was found to be limestone charged with a small percentage of sulphurets, (as much as 3 per cent.), including a very small proportion of galenite, and the very rare telluret of lead, (altaite). Nearly the whole formation is gold bearing. The auriferous mass is divided into two parts ("veins"), separated by a thin seam of talco-chloritic schist, 6 to 24 inches thick, which occasionally dwindles to a mere parting, too thin to notice. The entire formation, including the back and front "veins," is in places 60 feet thick. The strike of the vein is approximately northeast and southwest, and its dip about 45° west.



CATAWBA (KING'S MOUNTAIN) MINE, GASTON COUNTY.

Vertical cross sections of the bedded vein at different points indicated on Fig. 4; Fig. 1, the W. Richard's shaft (D); Fig. 2, Richardson (old) Engine shaft (B); Fig. 3, New Engine and Pump shaft (A). Drawn from notes of Northey, Fidler and others, by Geo. B. Hanna, January, 1883.

Scale: 200 feet to 1 inch.

The elevation of the surface of the ground at the mouth of the shaft at B (Fig. 4) is 35 feet below that of the shaft at A, and the surface at D is 5 feet below that at A.

The front "vein" is regarded as the best, and the foot wall the richest part of the front "vein." Assays Nos. 297 to 299 inclusive, show the

progressive decrease in value from the foot wall of the front vein to the hanging wall of the same, as follows:

GOLD ORE, FRONT "VEIN," CATAWBA MINE, GASTON COUNTY.

	(297)	(298)	(299)
Gold, ounces per ton	205-1000	170-1000	8-1000
Silver, ounces per ton	26-100	3-100	trace.

This front "vein" has generally an average width of 11 to 15 feet. The back "vein" is thought to show more sulphurets, but it is not easy to tell the difference between the two "veins" when they come together. The limestone is impure, being very siliceous and highly magnesian. The big chimney of ore, which gave the mine its reputation, had a very well-defined pitch of its own in the vein, northward.

The great width of the ore bodies, the ease with which the ore is mined and milled, and the small amount of sulphurets, combine to make the treatment of even the low grade profitable. The mill at the mine has now 40 stamps. During its past history the mine is said to have yielded three-fourths of a million dollars.

Plate No. XXIV shows the details of the relative position of the shafts and the extent of the underground work.

The following assays show the character of the ore:

GOLD ORE, CATAWBA MINE, GASTON COUNTY.

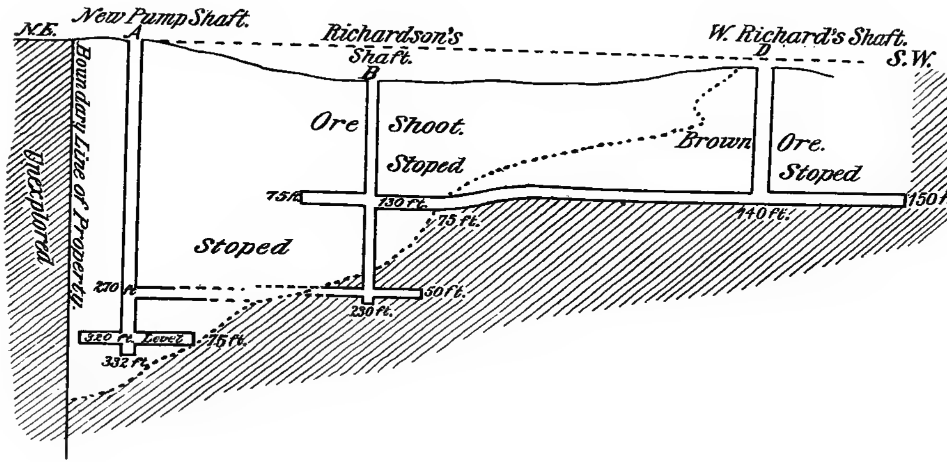
	(300)	(301)	(302)	(303)	(304)
Gold, ounces per ton	6-10	1-4	15-100	1 9-10	3 7-10
Silver, ounces per ton	1 22-100	48-100	25-100	1 36-100	2 6-10

The Crowder's Mountain (*Caledonia*) *Mine* is four miles to the east of the Catawba Mine, and on the east side of King's Mountain. It has very large bodies of ore, but they are of low grade; not much is known of their extent or value.

The Patterson Mine yields ore of a like character. It is in Gaston county, ¼ mile northeast of the above.

There are no mines worked in Lincoln county at the present time. Prominent among those which have been worked in the past are the Hoke and the Burton.

The Hoke Mine, 4 miles from Lincolnton, has been opened to a depth of 110 feet, and drifted upon for some length.



CATAWBA (KING'S MOUNTAIN) MINE.

A longitudinal vertical (in part) section, drawn largely from the notes of Northey and Fidler, 1883. Scale: 1 inch = 200 feet.

The Graham Mine has been described in the section on Copper (page 221).

Shuford Mine.—In Catawba county, this is the only mine where, at present, there is any semblance of mining. It is 4½ miles slightly south of east from Catawba station on the W. N. C. Railroad, and 6 miles west of Sherrill's Ford. It is believed to be at an elevation of 400 feet above Catawba River.

The mining tract comprises 425 acres, but the workable portion of this tract embraces only 20 acres. This latter area is covered with auriferous quartz, and the soil is also auriferous. The underlying schists or gneisses are penetrated by seams of auriferous quartz, which run in every conceivable direction through the surface, but of veins, in any just sense of that term, it may be doubted if there are any, although some of the seams, 12 inches or so in thickness, have considerable persistency in length or depth, and some general parallelism with the gneisses. This mine seems to have a striking resemblance to the Portis Mine in Nash county, the Parker in Stanly, and the Brawley in Mecklenburg. The entire surface is of "pay" material. The strike of these schists is N. 30° E.; the dip is easterly.

This mine must be worked by the combined method of hydraulic and mill treatment. The supply of water is always the most important consideration in work of this nature; and at the Shuford the supply is not large. The last work was given to the exploration of the seams in depth.

The A. D. Shuford Mine, ¾ mile southeast of the above, is also a placer mine.

In the gneissoid formation in Davie county there are several localities where gold has either been mined or found in some quantity. No attention whatever has been given to the mineral resources of this county either by residents or by outside visitors, and in consequence it is naturally looked upon as a county destitute of mineral wealth. A half-a-dozen names make up the list of known mineral localities.

The Butler (or County Line) Mine is 8 miles southwest of Mocksville. No work is being carried on there at present. The ore deposits are reputed to be large, but of low grade.

Callahan Mountain was worked a generation ago, with what results is unknown.

The Isaac Allen Mine is one mile northwest of Mocksville.

There are deposits of gold in Clarksville township, 7½ miles northwest of Mocksville; also in Fulton township, 7 miles northeast of Mocksville.

The Barnes Mine is in Alexander county, 8 milest west of Taylorsville.

In Caldwell county there are but few veins that are known to the public.

The Baker Mine has been described already as producing ores rich in galena, (page 203).

The Miller Mine is 2 miles east of John's River. It has both placer deposits and a vein, the former of which proved to be very rich in places.

Other mines in the neighborhood of the Baker are the Michaux, Pax's Hill and Corpening. Little is known of the character of either, or of their economic value.

The Gold Gravels and Accompanying Vein Deposits of the Piedmont and Mountain Regions.

The gold gravels in North Carolina have a distribution as wide as that of the crystalline rocks. Their occurrence at a number of places in the middle region of the State has been mentioned already in describing the mines of that region (pages 236, 241, 247, 254, 258 and others)—the most extensive and important of these deposits being in Montgomery and adjacent counties. It remains now to describe the more important of these deposits occurring in the Piedmont and mountain regions of the State. In these regions, as in localities already described, gold occurs both in the gravel beds and in veins; and at many places both placer mining and vein mining are prosecuted.

These gold-bearing gravel deposits usually occur along the lower slopes of hills and mountains, in the valleys between them, along the beds of streams, in their channels, on the benches, and in a variety of ways; also in ancient eroded basins or channels, which neither in situation nor direction bear any relations to channels of existing streams. They are usualty of no great length or breadth, but in some localities, viz., the South Mountains, Vein Mountain and Hunt's Mountain, they are quite numerous. Their thickness varies from a few feet to 30 feet

and more. In the basins and at the foot of the slopes, the gold usually occurs with the coarser gravel, near the bottom of the deposit—more largely along the bottoms of ancient and modern streams; higher up, on the sides of the hills, it is more generally distributed throughout the entire superficial earthy deposit

For a discussion of the structure and origin of these deposits, see appendices A, B and C, at the end of this chapter.

None of the localities to be described below have been studied with the thoroughness that is desired; but the region of the South Mountains has been sufficiently examined to permit a somewhat detailed description.

In the region last mentioned, a considerable amount of mining has been done, and the deposits (placers) here are the most extensive of the State. The area over which they are spread, in the counties of Burke, McDowell and Rutherford, is 15 to 20 miles long from northeast to southwest, following the general direction of the mountain ranges, and from 10 to 15 miles wide. It touches the northwest corner of Cleveland county, and probably includes the Polk county deposits, some 25 miles southwest. Gold occurs over the intervening space in Rutherford county, but little is known of its value for mining purposes.

Almost everywhere within the limits indicated gold is found, but not always in paying quantities. This large area may be divided into three narrow belts, the exact limits of which cannot be given, but which are nevertheless fairly well defined.

The first, or Rutherford belt, is on the head-waters of the First Broad River, in the extreme northeast part of that county, and just touches the border of Cleveland county. It is approximately 4 miles long, and from 1 to 2 miles wide, with Golden Valley as its central point.

The famous Burke county belt, with Brindletown for its main point, lies $2\frac{1}{2}$ miles northwest of the above. This belt is probably not more than $1\frac{1}{2}$ miles wide; it commences, as far as paying gravel indicates a commencement, at Bailey's Creek, 6 miles southwest of Morganton, on the road to Rutherfordton (see topographical sketch on page 312), and continues parallel to the main chain of the South Mountains, and on the spurs projecting out of its northwest side, for 10 or 12 miles to the head-waters of Cane Creek.

The third, or McDowell belt, is 4 miles still further west. It has a width of about 2 miles, with Hunt's Mountain and Nichols' Mountain

for its center. It is situated on the head-waters of North Muddy creek, and of the Second Broad River, and for the most part to the east of the road from Marion to Rutherfordton.

An immense quantity of gold has been obtained from the mines of this region since their opening in 1829—probably between two and three million dollars; and I am informed by some of the older citizens, that just before the California gold deposits began to attract attention, as many as 3,000 hands might have been seen at work on one of the streams of the region.

The operations of the past, when little capital and machinery were employed, were necessarily confined to such deposits as lay near water, or to which water could easily be brought. There is still a large amount of gold in the beds which remain untouched, as well as in those which have been carelessly or rudely worked over—some of them more than once. Indeed, some of the richest of these deposits have remained unworked on account of the difficulty of bringing a supply of water to their level, being situated considerably above the neighboring streams, on the higher slopes and benches of the foot hills of the mountains.

The greater part of these accessible places was long ago exhausted, and the work of the future will be on those deep-lying gravels, which require expensive digging in the removal of the overlying soil, or else a heavy and powerful stream of water to wash it away. The possibilities of remunerative work from the washing of gravel alone are growing less, and the attention of the chief operators is directed to a combination of the hydraulic and mill treatment. The rocks are altered and softened to a great depth, and readily yield to water.

Vein mining has rarely been found profitable in this section, as the veins are so narrow that they will not generally allow of exploitation one by one, as in ordinary mining; but a treatment of the ore "channel" as a whole is frequently applicable When the conformation of the ground admits, and the gulches are deep enough, the whole formation, including many seams (or veins) of quartz, may easily be undermined to a great depth, and the whole mass washed down into sluices, and thence to the mill for battery treatment and amalgamation of the auriferous quartz and hard masses. The veins are rarely of any great thickness, and the gold seems to have been contained in mere strings and thin sheets of quartz intercalated between the beds of decomposable mica schist and micaceous gneiss of the Archæan formation; and

among the gravel beds are frequently found fragments of quartz with strings, plates and crystals of native gold. These fragments evidently represented the entire thickness of the vein from which they weathered.*

Occasionally veins of moderate width, or even narrow seams, can be profitably exploited in the common way by adits from the gulches, entering at points so low as to do away with the necessity of expensive hoisting and draining plants; and gravity tramways can often be constructed to place the ore in the mill house with scarcely any handling. The surface over this entire belt is very rolling, in places mountainous, and affords opportunities for novel combinations, at once efficient and economical, and there is a growing tendency to apply the joint hydraulic and mill mode of treatment.

The foregoing statement respecting the occurrence of the auriferous bodies applies, in a general way, to all the localities, though all have minor differences.

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* This point needs a little elucidation and amplification. The veins or seams are not always intercalated, but very frequently cut across the strata either in length or in dip, and sometimes in both. The seams of quartz, of one or two lines in thickness, are found in so great abundance that, taken singly, they are little heeded; but there are also a great number of veins from 1 to 30 inches in width, and not a few which persist for long distances with an average width of 15 inches. These seams are frequently associated in belts or zones; in one case I saw not less than 6 in a belt of 100 feet, which varied from 1 to 6 inches in width; and in another case I saw 10 such seams, besides many mere threads or smaller seams of quartz, in the space of 200 feet. As respects their persistence in depth it is difficult to make any statement, as they have rarely been sunk upon to any considerable depth. It is quite certain that these seams of quartz are not the only source of the gold, for gold is occasionally seen in the schists themselves.

The veins of quartz of great thickness are generally poorer in gold than the narrow seams. Wherever in this region there has been surface-mining, these boulders are seen piled up, and evidently largely from veins of considerable size. Some assays of these large fragments, both from Brindletown and Golden Valley, show a very small contents in gold, viz.:

QUARTZ BOULDERS, AURIFEROUS GRAVELS, BRINDLETOWN AND GOLDEN VALLEY.

	(305)	(306)	(307)
Gold, ounces per ton	1-10	1-8	1-20
Silver, ounces per ton	trace.	trace.	trace.

The seams of quartz generally show a laminated structure; they are covered on the faces of the laminæ by oxide of iron (brown ore), and by sulphuret of iron and copper, occasionally by galenite, etc., and by the minerals resulting from the oxidation of these, such as malachite, black oxide copper, pyromorphite, etc.—G. B. H.

In the Rutherford belt there is not a locality now at work, and few mines require special mention.

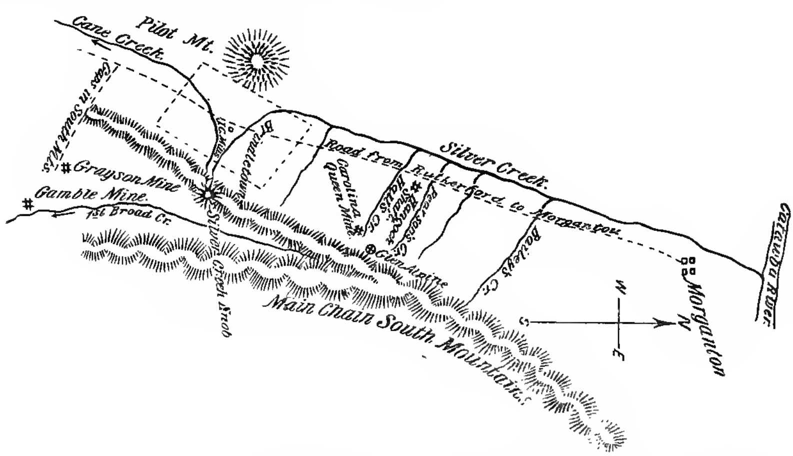
The Grayson mine has both gravel and several veins of low grade auriferous quartz.

The Lawson Smart is a gravel mine, 1 mile north of the Grayson.

The Gamble is a gravel mine, 2 miles southeast, immediately on the banks of the First Broad River.

There are several places on or near the road from Golden Valley to Brindletown; also in the South Mountains, where gold is found, and where possibly careful examination would show workable properties, but the surface is so rugged as to prevent exploration.

In the Burke county belt, the following mines are the most noted, or those recently worked. The position of these mines is shown on the Sketch Map of this region, given below; and many facts concerning the structure and origin of the gravel deposits will be given in appendices A and C, at the end of this chapter.



SKETCH MAP OF THE BURKE COUNTY GOLD BELT, INCLUDING THE BRINDLETOWN REGION. (BY J. C. MILLS.)

Scale: nearly 6 miles to one inch. The location of 1st Broad creek and the main chain of South Mountains is only approximate.

The Hancock Mine, near Glen Alpine, is worked as a gravel mine.

The Glen Alpine, in the same region, is also a gravel mine.

The Carolina Queen Mine, 1 mile southwest of Glen Alpine Springs, has several veins and a considerable area of gravel.

The only assays at hand of the vein quartz give:

VEIN QUARTZ, CAROLINA QUEEN MINE, BURKE COUNTY.

	(308)	(309)
Gold, ounces per ton	1-5	15 6-10
Silver, ounces per ton	1-2	2 3-4

It is needless to say that assay No. 309 is exceptional as a working ore; by careful hand-sorting the grade of ore could easily be brought somewhat above the contents of No. 308.

J. C. Mills Mine.—This mine, at Brindletown, is in the very heart of the most productive part of the belt. The mining tract contains 2,500 acres, located on the upper waters of Cane and Silver creeks, between the South Mountains and Pilot Mountain. (See Sketch Map on page 312.)

The extent of rich gravel on this property is estimated to be not less than 100 acres, but explorations may show it to be much more.

The old streams and basins, in which the ancient drift and wash are concentrated, are the richest in auriferous gravel.

Two ditches, aggregating something more than 11 miles in length, supply the necessary water for operating the mines, but not always with the pressure desirable for hydraulic work at the more elevated points, *e. g.*, the plants of the Pilot Mountain. If necessary, 1,000 inches of water could be brought to bear on the various beds of gravel, by two systems of ditches, with head varying from 50 to 100 inches.

Some exploratory work has been done in connection with the veins. On the mountain spur running northwest from Silver Creek Knob are 10 veins within a distance of 200 feet; among them is the Michel vein, which ranges from 4 to 12 inches in thickness; also a large vein 12 to 18 inches in thickness. The schists have a strike N. 35° to 40° E., and a dip 20° to 40° southwesterly. The more prominent of these veins (possibly all, for they have not been much explored,) have a strike N. 60° to 70° E., and a dip northwesterly, but nearly vertical.

There is still another big vein ½ mile north and a little farther west of this series of 10 veins, which is cut by several gulches, and can be entered by a tunnel 100 feet under the outcrop.

When attention has been fully directed to this matter of veins, and a well-adjusted system of treatment has been introduced, it is quite probable that other localities will be found entirely suitable for work.

The gold deposits in the third, or McDowell belt, are mainly on the lands of the Vein Mountain Company, or of the Marion Bullion Company (Granville Mine).

Deposits of the Vein Mountain Company.—The Vein Mountain Company's tract embraces nearly 6,800 acres. It is from 10 to 14 miles south of Marion, and near the road to Rutherfordton.

Two points on this tract have been especially prolific, viz., Hunt's Mountain on the north, and Vein Mountain on the south. The operations at the former (Hunt's Mountain) have been confined to the low lying gravels of the gulches, where a convenient supply of water could be had. A large amount of water has been lacking until recently, and hence extensive work could not be undertaken. The gravel worked over has been of the best character.

Several veins are found on this mountain, but have not been prospected. It will not be possible to estimate the extent of the veins of this part of the property till extensive hydraulic operations have removed the soil, and thus uncovered them.

Vein (Nichols') Mountain is 4 miles southwest of Hunt's Mountain; it has been far more extensively worked than the latter. The gulches leading up to the summit of this mountain, or on its flanks (some 6 or 8 in number), have been worked for 40 years, and still yield their contents; gold is well-nigh universally diffused through the soil down to the undisturbed bed. This part of the property is well supplied with water from the upper branches of the Second Broad River, which can be applied in most of the gulches.

Until quite recently only hydraulic work has been undertaken, but latterly the veins of this mountain have been prospected with some care; 20 or more (large and small seams) have been uncovered, and a few have been more carefully examined. Nichols' (Bissell's) vein is especially prominent among these; it is seen most conspicuously in Vein gulch on the southwest side of the mountain. The schists at this point have a strike northeast and southwest, and a dip eastwardly, while the veins here have a westerly dip, and a strike very nearly the same as that of the schists. The dip of Nichols' vein is very steep, probably not more than 10° or 15° from the vertical. This vein has been traced in a northeast direction for a distance of more than 2 miles; its width at the point under discussion varies from 10 to 30 inches, averaging probably 15 inches. There are few sulphurets present—a little copper and iron pyrite, stains of malachite, a small pro-

portion of galenite and pyromorphite, with peroxide of iron, make up the mineral charging, which (peroxide of iron excepted) is very sparingly distributed. This vein is entered by adits. The richness of the ore is shown by the following assays:

GOLD ORES, DEPOSITS OF THE VEIN MOUNTAIN COMPANY.

	(310)	(311)	(312)	(313)	(314)	(315)	(316)
Gold, ounces per ton........	1-8	65-100	1-5	1-2	3-10	6-10	3 4-10
Silver, ounces per ton	trace.	trace.	trace.	trace.	trace.	1 17-100	4 2-10

Deposits of the Marion Bullion Company.—The Marion Bullion Company operate the mine about 2 miles northeast of Vein Mountain, formerly known as the Granville Mine. The tract comprises 1,600 acres; only the placer deposits (gravel) have been treated, although veins are known to exist on the tract.

The company has other mineral resources as well as gold, but a description of them would be foreign to this chapter.

Several other localities are known in this neighborhood, but there are no records in the possession of the Survey which will justify a detailed statement.

The production of the South Mountain area is estimated to have been at least two or three million dollars. The readily available placer ground is exhausted for the most part, and the future work will be directed mostly to the lean placers and to the veins, which latter are extensive enough to give permanent prosperity to this important region.

The Polk county deposits, some 25 miles southwest, appear to be an extension of the deposits of the South Mountain area. The gravel of this county is much like that of Burke, McDowell and Rutherford, but the region is lacking in the natural advantages, which, in these latter counties, constitute so important a feature in working the deposits; and from this defect, chiefly, the mining has languished. In this county gold occurs in both placers and veins—strikingly similar to the placers and veins in the larger area just discussed. At present the localities are hardly more than names, for the desultory work carried on cannot be called mining. The better known localities are the Patty Abrams, Wetherbee, Red Springs, Tom Arms, Splawn, Ponder, Riding, L. A. Mills, Carpenter, Hamilton, Neal, MacIntire, Double Branch and Prince. These all had a good reputation in the palmy days of mining, while

the deposits contiguous to water lasted, but at present none can be worked on a large scale without a larger supply of water than can be obtained from the vicinity of the mines.

The eastern part of this county is comparatively flat, and a sufficient supply of water with a good head could be obtained only from the North Pacolet, in the southwest part of the county, by a ditch 20 miles long.

The Prince Mine is exclusively a placer mine, and it is not known that true veins exist there.

The Splawn Mine has a massive vein of low grade quartz.

Most of the other mines have veins so-called, by the weathering or breaking down of which the placers were charged. The remarks respecting the occurrence of seams and veins in Burke county will apply here; in some cases they conform to the bedding, and again cut it; but, although they have considerable persistency in length, they cannot be described as fissure veins. The persistence of these veins in depth is not quite so well settled; they are very narrow (1 to 3 inches wide—rarely 6 inches), and cannot profitably be followed below the line of standing water; they are, however, very rich in gold.

The mines at present worked are the Splawn, Double Branch and the Red Springs, but neither of these to any considerable extent. The lack of a favorable topography is the great drawback to mining in this region, but the improvements in mining machinery will, to a great extent, ultimately overcome this difficulty.

In the region west of the Blue Ridge are several gold mining localities, some of which at one time attracted considerable attention.

In Watauga county a limited area of gold-gravel is found on Howard's Creek, which was worked on a small scale before the war. Gold is also found in this county at Hardin's, one mile north of Boone.

In Buncombe county, indications of gold have been found on Cane Creek.

Gold Deposits on Boylston Creek.—Gold has been obtained for a long time from Boylston Creek, in Henderson county. A closer examination, in 1886, revealed an enormous deposit of gold bearing quartz and schists. Explorations were so favorable that a company was formed to work it, and the proper machinery erected for treating the ores. This has been done so recently that it is not possible now to speak of results.

So far as examined, the deposit is known to extend in a northeast to

southwest course for a distance of more than two miles, and with a thickness varying from 4 to 20 feet. This ore is all of milling grade, and carries a small percentage of sulphurets, which can be concentrated readily, and brought up to a high grade smelting material. There are indications of parallel bodies of ore.

There are two other gold regions—one in Cherokee, the other in Jackson county—where gold deposits occur of sufficient richness to warrant their consideration.

The gold of Jackson county is obtained almost entirely from placers or detrital beds. These are situated chiefly along the southern slopes of the Blue Ridge, near Hogback and Chimney Top Mountains.

Gold Gravels of Fairfield Valley.—The most important locality in this county is Fairfield Valley, where Georgetown Creek, one of the head streams of the Toxaway, is said to have yielded between two and three hundred thousand dollars. The deposits extend for several miles along these elevated basins, and have been by no means exhausted. The origin of the gold here is doubtless to be sought in veins in the Blue Ridge, which rises on the north and east—a precipitous wall of gray gneiss—to a height of 700 or 800 feet above the valley. It is along the base of this wall, where Georgetown Creek has cut a deep channel, that the gold is principally obtained.

The deposits in Transylvania county, east of the Blue Ridge, on the head waters of the French Broad, will probably be found to have similar origin, and are evidently a continuation of the same belt of deposits.

In Cherokee county, the gold belt is in the same body of soft slates and schists, which carry the limestone and iron. It is found in both veins and superficial deposits. The sands of Valley River yield profitably through a large part of its course, and some very rich "washings" have been found along its tributary streams on the north side. The origin of this gold is very near the limestone. A remarkably rich vein has been opened near the town of Murphy, known as No. 6, which immediately underlies the marble. This is a silver lead quartz vein, in which is imbedded a large percentage of free gold. There is a strong probability of other similar veins having furnished the gold occurring in the sands of the river and tributary streams above mentioned.

Southeast of the limestone is also a series of "diggings" along the lower slopes of the mountains, from near Valleytown to Vengeance

Creek, a distance of 12 to 15 miles. The gold is found here in the drift, which covers the lower spurs and terminal ridges of the mountains lying south of Valley River. The drift beds have a depth of from 10 to 20 feet, and an elevation above the river of 150 to 200 feet; they are remarkable for the great size of their quartz boulders and their very large and abundant staurolite crystals. These last indicate, with a good degree of probability, that the gold here is derived from the talco-micaceous schists several miles to the southeast, where staurolite crystals are found in place.

The continuation of this belt across the county is rendered probable by the existence of several mines in this direction, beyond the Hiwassee, as the Warren (or John C. Moore) Mine, on Brasstown Creek, and others on Notteley River, on the borders of Georgia.

Prof. C. D. Smith has furnished the Survey with some valuable observations on the gold deposits of this western region of the State, and particularly of their connection with the gold belts of Georgia. They are as follows:

'There is a gold belt, which passes from Union county, Georgia, crossing Brasstown Creek near the North Carolina line. This zone lies on the south of the Valley River zone, the gold occurring near the contact of the 'Huronian' (probably Cambrian) schists with the Laurentian rocks. On Gumlog Creek, just on the Georgia side of the line, quartz veins, rich in gold, occur in gneiss and mica schist on the south side of the creek; while on the opposite side of the creek, I have observed gold in talco-micaceous schist without any quartz gangue. On the lands of the Messrs. Brown, Messrs. Layed, Benjamin Brown and John C. Moore, quartz veins occur. From some of these I have seen very rich gold ores. This zone passes in the direction of Fort Hembree, and, crossing Hiwassee River, follows up the valley of the Tusquittah; and some of the ores from near the head of this creek I found rich in gold.

"There is but little gold on any of these ranges upon the eastern side of the Nantehaleh Mountains—I know of but two localites; one is on the waters of Briar Town Creek, on the eastern side of the Nantehaleh River, where it has been said that the quartz yields a fair per cent. of gold; the other locality referred to is in Macon county, about 12 miles in a southeast direction from Franklin, on the waters of Sugartown River. This last, as a gold mine, is isolated, having no connection with any system of gold bearing rocks.

"In the southeast corner of Macon county, in Whitner's Valley and Horse Cove, mining for gold has been carried on to a limited extent, both from branch and creek deposits; it is not known that veins exist there, since no systematic search has been made for them. There is apparently a system of trough-like valleys or gulches lying immediately along the southern base of the main ridge and between it and Buzzard Mountain, in which these mines exist.

"In 1856, I observed at one point in these valleys a narrow zone of talco-micaceous schist, which led me to conclude that such a zone once existed to a larger extent, filling up these narrow gorges or valleys, and by erosive forces have been carried away, leaving the gold in gravel beds. This zone probably continues northeastward through Cashier's Valley, and along the southern base of Hogback Mountain,* a section of the Blue Ridge. In the Toxaway, Georgetown and White Water Valleys, mining has been done similar to that in the Horse Cove.

"At one point at Hogback, I have been informed by old miners, there is a spring breaking out of the rocks, from which the sands daily accumulating below the spring, are rich in gold. The zone passes through Blue Ridge into Transylvania county, and down Boylston Creek.†

"A proper exploration of this region of the State would probably reveal mines like the Gum Log, in Union county, Georgia, which yields blende and argentiferous galenite, as well as gold."

A few statements concerning the gold mining interests of the State may be made by way of conclusion. It is doubtful if there be any "bonanza" mines in the State, and those who venture into mining in North Carolina with such an expectation are likely to be disappointed. But there are localities where judicious investments at reasonable prices, and well-planned enterprises with adequate capital, may hope to find opportunities for steady work and a just expectation of moderate and long continued dividends.

There is not a large field at present for metallurgical work, but the introduction of such methods, apparently, is not likely to be long delayed. The facilities such establishments would afford to the mining interest are evident, and will naturally stimulate business and increase

* See page 317, for other memoranda concerning this belt. † See page 316.

the number of mines operated. A fair market for mine matter, that under other circumstances would be of little value, materially enhances the returns to the mine operators.

It is, however, to reforms in mining administration that the greatest benefits are likely to be due. A more thorough acquaintance with the nature and occurrence of ore bodies will cut off a great source of waste of capital. The introduction of cheaper and better explosives and machinery will also tend to the same end; this is particularly true of efficient concentrating machinery. Better modes of amalgamating, and better practice will powerfully contribute to this end.

There is no promise at the present time of the introduction of any absolutely new processes, but advancement will be due to new combinations of familiar methods, and to the perfecting of the details of practice, and in reducing the entire administration to a business basis; for there is the same necessity of exact and careful methods in this, as in any other business—there is no place for extravagance or carelessness.

Speculation has been a serious drawback to the prosperity of the mining industry of this section, and there is neither room nor basis for speculative enterprises.

It is hoped that the forgoing pages will properly exhibit the condition of mining in the State, so that the prudent business man will be able to act judiciously.

APPENDIX A.

THE GOLD GRAVELS OF NORTH CAROLINA—THEIR STRUCTURE AND ORIGIN.*

BY PROF. W. C. KERR, STATE GEOLOGIST, RALEIGH, N. C.

[Read at the New York Meeting, February, 1880.]

When Agassiz and his party of geologists commenced their exploration of the interior of Brazil and the Amazon region, one of the first and, to the last, one of the most novel and striking phenomena which met them everywhere was the great depth of decomposed or partially decayed rock *in situ*, which mantles, and for the most part conceals, the underlying strata. The same facts strike all geological observers from the North who happen to penetrate the middle and southern latitudes of the Atlantic States. In North Carolina, *e. g.*, the entire middle and western regions, outside of the Quarternary† clays, sands, and gravels of the East—that is, all that portion of the State occupied by the Archæan and Mesozoic rocks—show everywhere this peculiarity, so new to those accustomed to glaciated surfaces. Not only do the hills and slopes, the mountain chains and spurs, present everywhere to the eye this superficial covering, but even the more level tracts and the valleys. The railroad cuts give very good exposures of this covering, and furnish, everywhere, abundant opportunities for the study of its structure and history. Some of the more obtrusive facts are these: The thickness of this covering varies from a few feet to 30 or 40, and often 60 and 75, and even 100 feet, and bears an obvious relation to

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* Reprinted from the Transactions of the Am. Inst. of Mining Engineers, Vol. VIII, page 462.

Some of the statements of this Appendix are also given in Appendix C, but the facts given in one of these appendices and not in the other are considered sufficient to warrant the reprinting of both. See also page 308 of this Report.

† On the geological map accompanying this Report, these deposits are classed with the Tertiary.—J. A. H.

the character of the underlying rock, being least where this is most refractory, and *vice versa;* the rock is generally nearest the surface in the crests of the hills. The upper portion of this earthy envelope for several feet beneath the soil is homogeneous and structureless; but lines of structure soon make their appearance, becoming more pronounced with the depth. These lines of structure are commonly coincident with bands and ribbons of differently colored earths, which, on closer inspection, show differences in their materials also, these differences becoming more and more strongly marked as they are traced downward, until they pass by insensible gradations into the solid rock beneath. The obvious and necessary conclusion from these observations gives itself, viz., that the rocks of the region are and have long been undergoing a slow chemical decomposition and disintegration from the action of atmospheric forces, this decay being too rapid, however, to be overtaken by the abrasive and transporting power of these same agencies.

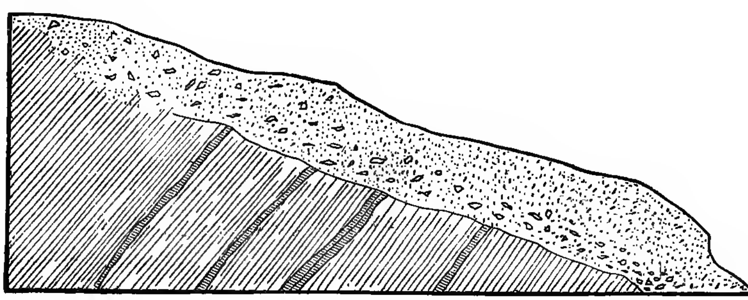

Fig. 1.

So far the general and obvious facts, plain to be read by the man that runs. A little closer inspection reveals another set of facts. It is easily discovered that these mantles of earth and half-decayed rocks are not strictly *in situ*, but have been subjected to some sort and degree of movement, and that the materials have undergone at least a partial rearrangement in certain situations and under certain conditions. In general, on the summits of the hills there has been no change, but descending the slope, however gentle, a tendency to a sorting and arrangement of materials appears, and this becomes more observable with the distance. At first the fragments of quartz and other hard rocks are sharply angular, and are distributed equally and irregularly through the mass, or in lines corresponding to the bedding of the rocks. De-

scending a few rods, the rock fragments have "settled" somewhat; they are found more thickly strewn towards the bottom, and are less angular. Descending still further, all the coarser fragments are found accumulated in a layer of cobbles or pebbles, with only the interstices filled with earth and gravel.

Combining sections of this covering taken from different points, from the hilltop to the bottom of the slope, which commonly terminates in a ravine or valley, or the bed of a stream, we have the appearance shown in Figure 1.

The obvious interpretation of these facts is that there has been a movement or flux of the earthy mass in the direction of the slope. And this notion is confirmed by an occasional observation which is represented in Figure 2.

The difficulty at once arises how to account for a flow of such materials with such results. The ordinary action of flowing water is, of course, excluded. The mere action of gravitation will not account for

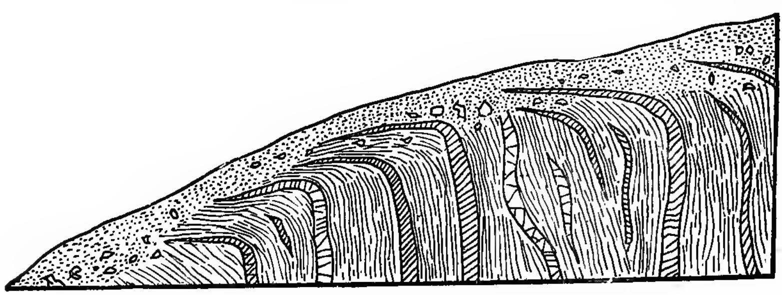

Fig. 2.

the phenomena—slipping or sliding down hill. This, doubtless, often happens on very steep declivities, but such cases are quite exceptional and are easily distinguished. The movements we are considering have taken place at every degree of inclination, from one degree and less upwards, and occasionally on a level, *or even up hill.*

After puzzling over these phenomena for half a dozen years, and wondering that there is no explanation in the books, or even any discussion of the subject or note of the facts, not even in Geikie's *Great Ice Age*, it occurred to me that the only possible solution must be sought in the action of frost. The alternate freezing and thawing of such a mass of earth must needs produce just the effects we have been considering. The earth, saturated with water, in the

process of consolidation under the action of cold would, of course, expand just as if it were all water, and in thawing there would be a slight movement of the parts and particles of the mass *inter se*, and of course a settling of the heavier fragments; in other words, the movement would be the same in kind (though not amount) as that of a glacier. These masses may be considered earth glaciers. And I have ventured to denominate this group of phenomena and these peculiar supeficial accumulations, *frost drift*. Now the ordinary glacial phenomena are wanting in North Carolina, with, perhaps, the exception of a few morainal rides in the gorges of the higher mountains. But during the glacial period, of course, the cold must have been intense enough to account for the depth and extent of action which the theory of *frost drift* supposes.

I was led to these results from the particular study of the gold deposits of the State. They have all been formed in this way. There are probably five hundred square miles of gold drifts in North Carolina. They are found through a range of four hundred miles east and west, from the lower waters of the Roanoke, near Weldon, to the extreme western border, the county of Cherokee. And they belong to all the different subdivisions of the Archæan rocks of the State. The two most extensive deposits are found in the middle region, on the Yadkin and Catawba Rivers, among the low ranges and spurs of the mountains. The schistose and slaty rocks, highly inclined and much contorted and dislocated, are in many places penetrated by innumerable small veins and seams of gold-bearing quartz. (See Fig. 3.) In

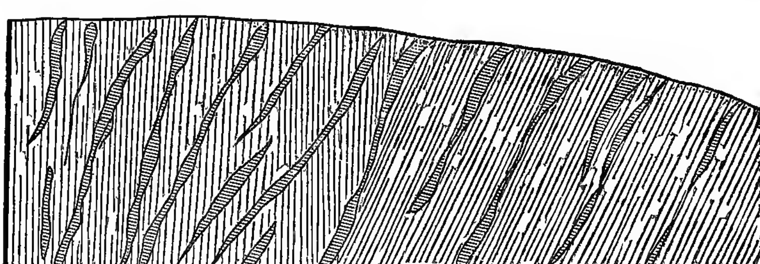

Fig. 3.

the disintegration and breaking down of these rocks, and the movements of the *debris* in the manner described, it is evident that the gold particles, with the heavier crystalline minerals, will be found accumu-

lated near the bottom of the drifts, on or near the surface of the bed-rock, or "slate," as the miners call it.

The gold mining of modern times began sixty years ago in this region from the accidental discovery of a twenty-eight pound nugget by a boy in one of the streams of this region. Most of the simple and effective appliances now in use everywhere for the separation of gold from such deposits—the long tom, the sluice, the riffle-box, etc.,—were devised and used in this region, and were carried hence to California when, twenty-five years later, the trained miners of this region emigrated in a body to that newer and richer field. Since that emigration there has been but little placer mining done in North Carolina. Still this sort of mining has never entirely ceased, and in some sections, and by a few families, it has been followed continuously to the present The richest deposits within reach of water have been worked over, but there are large areas still untouched, because inaccessible to water without considerable outlay for ditching, canalling, and fluming, to which neither the capital nor the enterprise of the region is equal.

APPENDIX B.

ON SOME PECULIARITIES IN THE OCCURRENCE OF GOLD IN NORTH CAROLINA.*

BY PROF. W. C. KERR, STATE GEOLOGIST, RALEIGH, N. C.

[Read at the Washington Meeting, February, 1882.]

The distribution of gold is obviously much wider than is commonly supposed. Besides the usual matrices, vehicles, or associates, such as quartz, pyrite, chalcopyrite, etc., I find it occurring in quite a range of common rocks. For example, at the Rhodes Mine, in Gaston county, a body of 9 to 12 feet of decomposed, light-gray gneiss was worked together with the strings of quartz, and yielded from six to ten dollars to the ton.

A mine in Moore county yields its gold mainly from a feldspathic schist.

In the famous King's Mountain Mine, in Gaston county, the gold is obtained not only from the seams of quartz in a blue, hydromicaceous schist, but a 60 foot ledge of greyish-blue, fine-grained, schistose limestone is quarried out bodily and sent to the stamps. It is gold-bearing throughout.

In Montgomery county the singular concretionary, conglomeritic, quartzite schist, which contains Emmons's *palæotrochis*, is gold-bearing over wide tracts of country. This fact was noticed by Dr. Emmons. But a still more striking and significant fact is, that a large part of the gold of Montgomery, Davidson and Randolph counties, on the waters of the Yadkin and Uharie rivers, is contained in ledges of thin-bedded quartz slates, often pyrophyllitic or feldspathic, and frequently scaly and micaceous.

The range of noted mines, extending twenty miles northward from near the mouth of the Uharie River, including the Russell, Beck, Laughlin, Jones and others, come under the description just given. These slates, shales, or schists, stand almost vertical, and are generally decomposed to a considerable depth, 20, 40 or 50 feet, and are excavated

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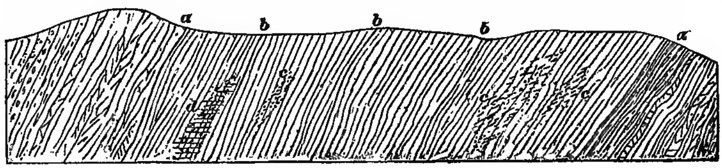
* Reprinted from the Transactions of the Am. Inst. of Mining Engineers, Vol. X, 1882, page 475.

en masse, generally with pick and shovel, sometimes through a cross-section of several hundred feet in length, and the whole mass is carried through the stamp mill and rocker.

The accompanying diagram represents the last-named mine in cross-section. It is simply an open cut in the side of a hill, 50 to 70 feet



high, formed by a ravine which has cut across the strike of the formation. The workable strata, between *a* and *a*, differ imperceptibly from the bounding rocks, and they pass insensibly into each other, the outside strata becoming gradually more heavily bedded, hard and quartzose. Within the worked area there are lean strata, that are harder and thicker, and more quartzose or chloritic, as at *b*, *b*, *b*. At *d* a portion of the strata is charged with a fine-grained pyrite, that sometimes constitutes a large percentage of the rock for 2 or 3 feet in thickness. At *c*, *c*, *c*, portions of the strata are crusted with ferruginous scales and limonite, resulting from the decomposition of pyritous masses of slate. This mine may be taken as a type of an extensive zone of mines that extends even beyond the Yadkin and into South Carolina, including the well-known Brewer Mine.

Within a few months past I have found that the gray, much-jointed quartzites and felsites of the Huronian hills, on the eastern side of the great slate belt, carry a workable percentage of gold through masses of great extent.

Gold has also been found by Mr. Hanna, of the Charlotte Mint, in a trap-dike that is to be seen in that vicinity.

From the facts here given, it would seem that gold is so widely diffused that we may expect to find it in any kind of rock.

APPENDIX C.

ON THE ACTION OF FROST IN THE ARRANGEMENT OF SUPERFICIAL EARTHY MATERIAL.*

BY PROFESSOR W. C. KERR.

To a foreign geologist, entering the Middle and South Atlantic States for the first time, a hundred miles or more from the coast, the most striking and novel feature of the geology is the great depth of earth which almost everywhere mantles and conceals the rocks. This is readily discovered to be, for the most part, merely the result of the decomposition *in situ* of the exposed edges of the underlying strata. The vertical and highly inclined bedding lines of these strata—Archæan schists, gneissess and slates—are distinctly traceable by the eye through this superficial earth-covering, and are seen to pass by insensible gradations into the undecayed rock beneath. Its depth varies from a few feet to twenty or thirty, and sometimes twice that and more, being usually greatest on the slopes of the hills.

So much is obvious, to the most casual observation, in the railroad cuts, and in the gullies by the roadside. But a more minute and systematic study of these superficial earths soon shows that the matter is not nearly so simple and easily explicable. It very soon becomes evident to the careful observer that there are in fact three kinds of earthy layers, each having a different structure and origin. Their usual color is brick-red to brown of various shades, from the oxidation of the iron-bearing minerals.

The banded structure of the original rocks, above referred to as characteristic, being marked by difference in color and composition, according to the varying lithological and chemical constitution of the underlying strata, does not reach the surface, but fails at the depth of four or five to eight or ten feet or more, the materials above this being quite homogeneous.

This thin top layer is well nigh universal, and always recognizable. A little attention suffices to show that it owes its difference in structure and appearance to the penetration and the mechanical and chemical

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action of the roots of forest trees. The mechanical action of these roots has broken up and obliterated the lines of bedding and commingled the different materials, and their chemical action, living and in decay, has changed their composition and color, sometimes bleaching the whole mass in a degree which decreases with the depth, and not unfrequently in a very irregular manner, so that a section presents a pied surface—red, of various shades, mingled with splotches of a gray, or pipe-clay color.

A second division of the superficial beds in question underlies (or replaces) the preceding, but is much less extensive, being found chiefly on the hill slopes and occasionally arching, in thinner mass, over the tops of flattish ridges and swells. It is found throughout the hill country and the mountain section of the State, being most conspicuous in the Piedmont, and passing, eastward, insensibly into the Quaternary* deposits. The thickness varies from a few inches to twenty, thirty and even fifty feet, and the beds are very irregular in form. These deposits are best developed and may be most successfully studied in the gold gravels or placer beds of the State; but their structural features may be seen in the railroad cuts almost everywhere.

This division is, in general, readily distinguishable from the underlying mass, first, by a complete obliteration of the bedding lines and by a sharp line of separation, and secondly, (from both the other divis ions) by a thorough commingling and a more or less obvious (if generally partial) re-arrangement of its materials—an obvious *tendency to restratification,* in an approximately horizontal direction. This generally consists merely in an aggregation of the coarser materials of the beds toward the bottom, or along certain horizontal lines.

This and other features of these beds will be best understood from a few diagrams. Figure 1 represents a section seen in a railroad cut

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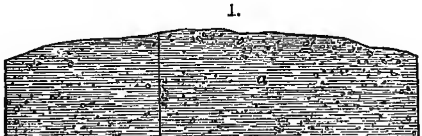

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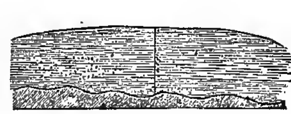

near Henry Station, not far from the eastern base of the Blue Ridge, in McDowell county. We have here a mass of earth with fragments of rocks, mostly quartz, of various sizes, in a nearly homogeneous accumulation, with scarcely a discernible arrangement. Figure 2 rep-

* Later recognized by the author as Tertiary.—J. A. H.

resents a similar deposit of much less depth, in a railroad cut at Cary, near Raleigh; and figure 3, one near Rockingham, in Richmond

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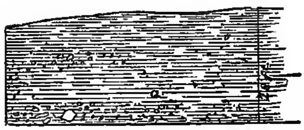

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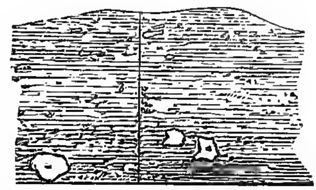

county—the last two near the margin of the Quaternary deposits. In figure 4, from the same locality as figure 1, we have an accumulation of coarser and more heterogeneous materials. In the three former cases there was simply earth with small fragments of quartz; in the latter, besides quartz fragments and bowlders a yard in diameter, fragments, large and small, of gneiss and horneblende slate and other underlying rocks. In figure 5 the deposit is shown as capping the summit of a hill, a phenomenon of not uncommon occurrence in the Piedmont region: the section here shown is found near Old Fort, in the upper Catawba Valley. In this and in figure 6, two points are illustrated, viz.: the partial arrangement of the materials, the accumulation of the larger fragments and pebbles

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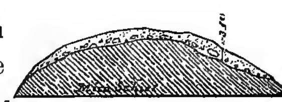

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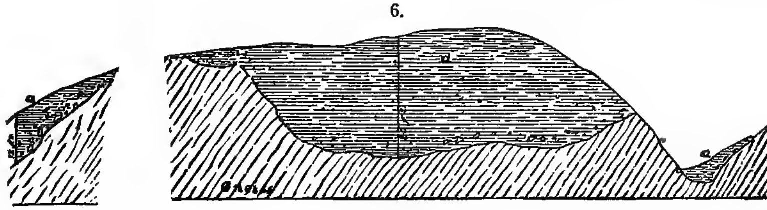
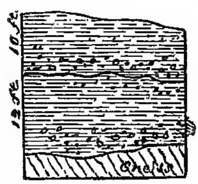


toward the bottom of the beds, and along certain horizontal planes, and the complete independence of these deposits on the form of the surface on which they lie. They also illustrate another important point, viz.: that the present topography of the surface is the result of *an extensive erosion, subsequent to the accumulation of these deposits*, so that the hills and valleys of the present and the subjacent topography have often changed places, and these present deposits are mere remnants of much larger and wider accumulations which once filled up the valleys and mantled over the hills and obliterated the features of a former

topography. This conclusion is abundantly attested by numerous observations.

Figure 7 brings out another common feature—the occurrence of periods in the deposits, or of several deposits one upon another. This section is taken from a gold placer in Brindletown, Burke county, near Morganton, at the foot of a little mountain, called the Pilot, the lower slopes of which, next the valleys and streams, are covered with placers of varying depth, up to fifty feet. The same thing is shown in another placer mine on the same side of the mountain, a section of which is given in figure 8. The division between the successive beds at this point is not as sharp as represented in this diagram, although in many cases they are so. The lowest stratum (1) which lies on the decomposed gneiss and mica schist (the slate of the miners), is a four to five foot stratum of slightly rounded quartz fragments of an inch or two to six inches in diameter, the interstices filled with gravel and earth—a coarse half-compacted conglomerate, which gives place, upward, to a bed of gray, or ash-colored earthy clay (2), six or eight feet thick, above which lies twenty-five to thirty feet of red gravelly earth (3), with a few small scattered quartz fragments.

7.



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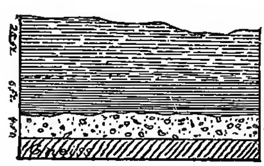

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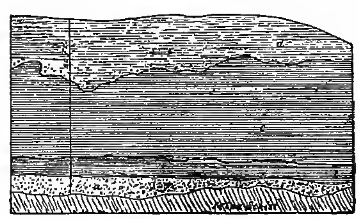

Figure 9 represents another similar deposit half a mile distant from the last, the section being taken, as were the last two, in the gold mines of Col. J. C. Mills, the last at the eastern base of the Pilot, and at a somewhat lower level. The two lower division lines, in this case also, are a little too sharp, the only distinct breach of continuity being found between the strata *c* and *d*: *a* and *b* shading into each other, somewhat abruptly, and so *b* into *c*. In this section *a* and *c* correspond to 1 and 2 of figure 8, *b* being an interpolation, and furnishing the explanation of the bed 2. This interpolated bed is a peaty, black, gravelly soil, with blackened stems and bark of trees and fragments of

wood and grass blades, roots and stems. The bleaching of bed 2, figure 8, and of *c*, figure 9, is evidently due to the solvent action of the humous acids from the old soils of the slopes from which this deposit came.

Figure 10 is a section in a railroad cut near Statesville, in Iredell county, which shows two muck beds *a*, *a*, in contiguous depresssions

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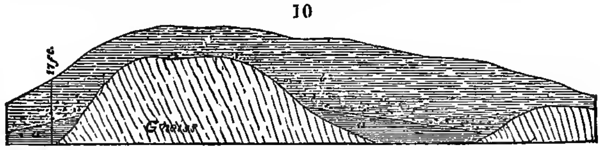

which have been buried deeply by earthy accumulations, which show only a slight tendency to stratification, in the apparent *settling* of the quartz fragments.

Now, in none of the foregoing sections is there any indication of a proper stratification by the action of water. Indeed, it is clear enough that the action of water is excluded by the most obvious features of these deposits. It is proper to say here, however, that there are deposits here and there, which do show traces of such stratification; and occasionally, in certain situations, deposits like those above described, in some parts of them, show slight and partial indications of water action. These, however, are exceptional, and constitute a class by themselves, and need not detain us here.

The diagrams above given represent the general character of hundreds of sections to be seen along any of our railroads. They offer no hint or suggestion as to the origin of these deposits, the cause or mode of their formation. The most frequent and conspicuous of these phenomena are seen, as stated above, in the Piedmont. The railroads of necessity follow the course of the river valleys, and the sections are consequently those of the lower ends of the jutting hills and spurs which slope down into the margins of the plains: that is, they are tranverse sections of these ridges and slopes. It goes without saying, that the arrangement of the materials of these deposits, the *settling* of the heavier elements, can only have occurred in consequence of some sort and degree of movement of the mass. It is equally evident that such movement, whatever its cause, must have been in the direction of the slope of the surfaces on which they lie, that is, at right angles to the usual plane of section. And it is only by observing the relation of

the arrangement or settling, to the situation on the slope, and by studying this arrangement at different elevations along the line of movement that a clew to their origin could be had. The gold mines, at different elevations near the base of the Pilot, furnished the opportunity for such comparison. It was thus seen that the distribution of the materials of these deposits at their upper portions is represented by figures 1, 2 and 4; at a lower point by figures 3, 6, 7; and still lower by 8, 9. That is to say, a *longitudinal* section, down the slope, would be expressed by figure 11. Above, toward the left of the figure, the angular fragments of rock are distributed through the mass, but they

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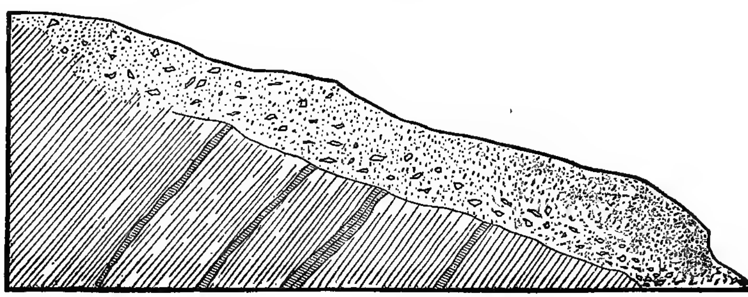

are seen to descend, and to accumulate with the descent, toward the floor of the deposit and to become more rounded. It may be stated here that the coarse particles of gold in these placers are found with the pebbles,—gravel, and where these have accumulated at the bottom, only this part of the deposit is usually wrought, unless water is abundant; but at higher levels, where the gravel is scattered through the mass, the coarse gold is equally diffused.

The movement down hill then is evident, and the degree of arrangement or settling is proportioned to its amount. Of course the first suggestion that occurs, on this presentation of facts, will be that gravitation may have given rise to the motion. But this theory would not be entertained for a moment by one familiar with the actual sections. These deposits occupy the *lower slopes* of the hills, just where they meet the plains, the inclination varying from two or three to ten and rarely twelve degrees. This is obviously quite insufficient to give rise to any sensible movement from gravitation. Such movements of loose earth and stones do occur, but only on steep slopes of 40° and upward; and such accumulations are not uncommon at the foot of steep declivities; but these are distinguishable at a glance from the deposits in question.

And further, instances are not unfrequent of the movement of these deposits on a dead level, and even *up hill*, over local obstructions or irregularities of surface.

The following diagrams illustrate these points, and show the grounds on which the theory adopted for the solution of the problem of the formation of these deposits rests.

12.

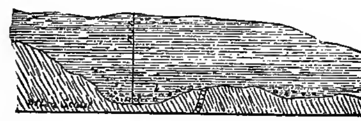

Fig. 12 represents a section in a railroad cut near Morganton, which gave the first hint of the true theory of the origin of these beds; and fig. 13 is a similar section ten miles west of the former, near Muddy Creek bridge. In both these cases the vein (shown at *a*) is distinctly seen to be the source of the jointed, rhomboidal quartz fragments which are scattered along the floor of the deposit toward the right hand end of the diagram, a distance of one to several rods.

13.

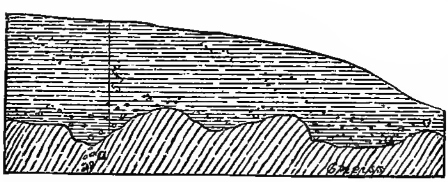

Fig. 14 represents the opposite side of the same railroad cut as fig. 12. In this the fragments are scattered right and left from the vein.

Fig. 15 is a similar section from a railroad cut in Richmond county, near the Pee Dee river. In this case a large quartz vein in a chloritic argillaceous slate has been broken down by the denudation which the rocks have undergone, and its fragments have been carried to the left and have settled part way through the moved mass, the upper portion of which has been removed by subsequent erosion.

14.

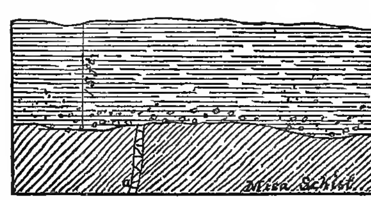

Fig. 16 represents the first stages of movement across a small vein. This is a quartz vein seen in section in a gold mine on the slopes of the South Mountains, near Brindletown. The thin-bedded, soft, decomposed mica schists are intersected by numerous small veins and seams of a granular (saccharoidal) quartz, varying from a usual thickness of one to three inches (occasionally four to six) down to a mere line. These thin veins and seams are so numerous in places, and contain so much free and loose gold in the

crevices and on the walls that it is profitable to sluice down the whole mass. The quartz is also rich enough for milling, yielding from ten to forty dollars to the ton. Other illustrations of these veins may be seen from the same mine in figs. 19 to 21.

It is clear, then, that these deposits were not accumulated by the action of water, nor by gravitation; and they present none of the features by which glacial deposits are usually recognized. No precisely parallel phenomena seem to have been observed elsewhere, or they are not recorded. And they remained an enigma to me for several years, and until such sections as shown in figs. 12 to 16 were discovered and studied. In these, and in those subsequently found in the gold placers, the character and amount of movement were clearly revealed.

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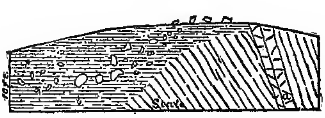

16.

The explanation which these facts have suggested, and which subsequent observation in this State and in other States has fully confirmed, is that the movement in question, to which the gradual settling of the heavier particles and fragments through the mass is due, *was produced by frost*, and that these deposits *are of glacial age.* As the earth is often frozen in Canada, and even in Vermont, during severe winters, to a depth of eight or ten feet, and as in Labrador and other sub-arctic regions the frost of the present winters penetrates to a much greater depth, so, it is evident, that during the prevalence of the great ice sheet over the northern end of the continent, as far down as Pennsylvania, and the prevalence of an arctic climate in these middle latitudes, the earth was annually frozen to a depth equal to the maximum thickness of these deposits. The alternate freezing and thawing of the saturated mass of decayed rocks, constituting the pre-glacial surface, would of necessity produce just the movement and settling which are described above. That is, this freezing and thawing would give rise to precisely the same movements of the mass, and of the particles *inter se*, as are seen to occur in the true glacier, *differing only in amount.* In other words, these masses were *earth glaciers*, and these deposits may be denominated *frost drift*, as distinguished from proper glacial drift.

I do not see how these conclusions can be avoided. It seems evident that such phenomena must have occurred during the prevalence of cold of the intensity which an admitted artic climate must have produced. And, if so, similar effects must be produced in arctic climates, and to some extent in the high latitudes of climates less intense, to-day. And, if so, too, similar phenomena may be expected to be found in regions farther north, produced during the retreat of the ice when these regions were successively subjected to the same degree of cold. Of course these effects would be visible only in exceptional localities, where the surface was not buried under glacial debris, and where the exposed rocks were capable of comparatively rapid disintegration. And, in fact, I have seen in Philadelphia and vicinity, phenomena which plainly come under this class. During the Centennial Exhibition, Market street was extended westward a square above Forty-fourth street, and a hill of some twenty feet was brought to grade in the process. Happening to pass during the excavation, I took a sketch of the exposed section, which is given in fig. 17. The rock is gneiss and mica schist with

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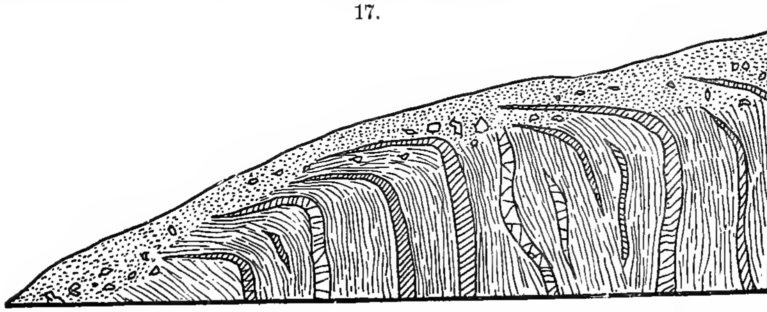

hornblendic and chloritic strata, inclined at a high angle, and decomposed, for the most part, the entire depth of the cut, presenting a banded section of variously colored earths. The most striking and novel peculiarity of this section is shown in the sketch, viz.: the gradual drawing out—attenuation—of these colored bands, as the parts of them in succession were moved down the slope. This section furnishes a new illustration of the character of the relative motion of the different parts of the mass.

As the thickness of the deposit at this point is not more than three to four feet, and there was no reason to suppose any recent or rapid denudation, the probability is strong that it is of recent (*present*) origin, the existing climate of Philadelphia being equal to the produc-

tion of such effects. Fig. 18 represents a similar section in a drift of a mica mine in Yancey county, this State, near the base of the Black Mountain.

Among the inferences from the above conclusion, in the way of a corollary, is this important one, that the deep decomposition of the

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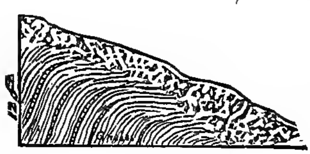

rocks of these latitudes has been effected entirely in post-glacial times, since the movement of these earth glaciers would sweep away everything movable, down to the solid rock; and the frost was sufficient to carry the movement to the greatest depths of previous decomposition. And this conclusion is confirmed by two observations: first, that the force which was sufficient to remove the bowlders and rock fragments which often constitute the lower portion of these deposits—frequently of several tons weight—would abrade and remove everything but the solid rock; and second, that the irregular form which the floor of these deposits often exhibits, as seen, for example, in fig. 13, corresponds to the unequal decomposition of the different strata of these very variable schistose rocks. This of course excludes any theory like that sometimes broached, which undertakes to account for this phenomenon, by invoking the action of a paleæval atmosphere surcharged with carbonic acid.

As already stated incidentally, the gold gravels, or placers, of this State, of which there are several hundred square miles, belong to this class of frost drifts. The miners in these deposits usually wash only

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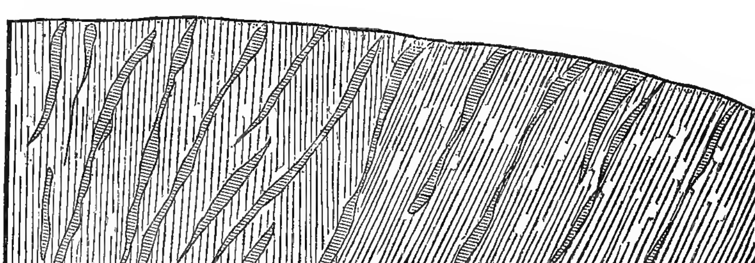

the lower stratum of "gravel," or pebbles, which lies against the bed rock, or *slate*, together with an inch or two of the surface of this slate, on which the coarser gold particles are lodged. The gold and the quartz pebbles are derived, as above indicated, from thin veins and

strings which penetrate the more thin-bedded mica schists. As these are disintegrated and broken down and moved, in the manner just described, or abraded and swept down by floods, these pebbles with the coarser gold are collected either in the manner described, or in the beds of the streams. Examples of these veins are shown in fig. 19, which represents a common aspect of them in section, in the mines previously alluded to, in which the veins themselves and the including mass of decomposed rock are sluiced down and washed just like a placer. In fig. 20 a vertical section of 20 feet of a single vein of this description which is a thin sheet of quartz, of an inch and less in thickness, yet rich enough to have been followed to a depth of 20 and 30 feet for many rods. Fig. 21 represents the floor of another mine at the same locality, in which several such thin sheet-veins are wrought in one cut, the vein-matter being reduced to nothing, at certain points, leaving a mere joint or fissure plane.

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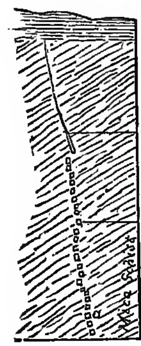

21.

In fig. 22 the relation of the placers to the topography, and of both to the governing geological conditions, are exhibited. This diagram represents an ideal section southeast and northwest, transversely to the strike, across two of the richest and most noted gold valleys, separated by the Pilot, already familiar to us; these are the valleys of Silver Creek and Muddy Creek, known as Brindletown and Brackettown. The Pilot and the ridge of the South Mountains (the left in the section), owe their existence to the

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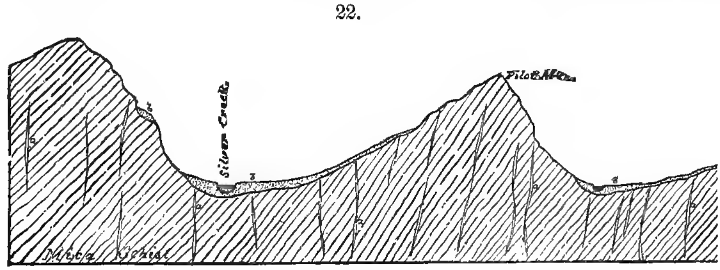
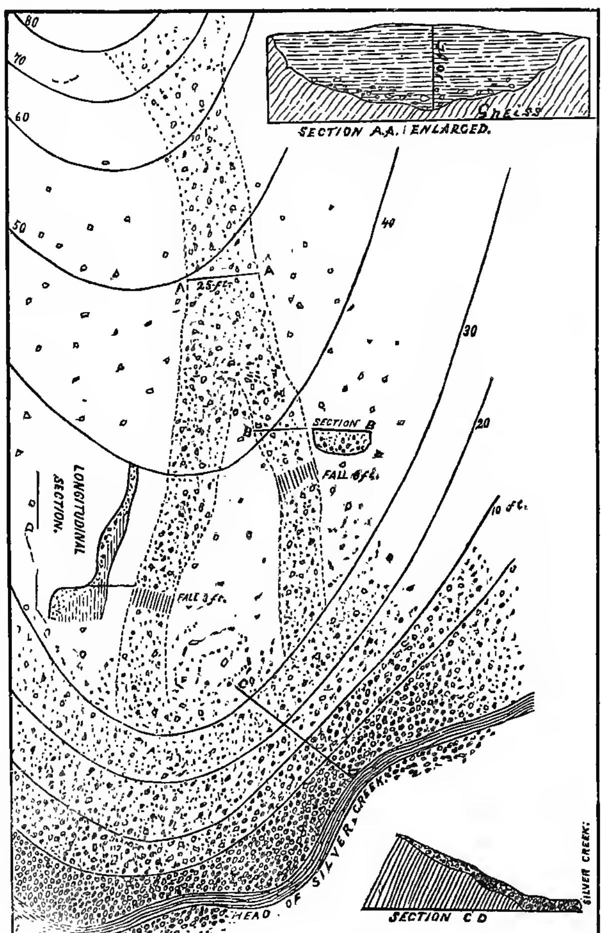


hard and heavier bedded gneisses of which they are composed, while the valleys have been scooped out of the softer and thin-bedded mica schists and hydromicaceous rocks, which are also more abundantly veined. It is an old observation of the practical miners, that the gold

deposits occur only on the east (and south) slopes of the mountains, while the opposite slopes are comparatively barren. The reason is obvious from an inspection of the diagram. The thicker bedded rocks have fewer veins, and the southeast slopes are the long ones, while those opposite are steep and short; and much the larger part of the abraded vein-bearing masses have been removed from the space above these long slopes.

23.



It has already been stated that, as shown by the most obvious features of these deposits, they have been much more extensive than at present. In some cases, over considerable spaces, the deposit has been entirely

removed by denudation, leaving only the floor covered with a layer of quartz pebbles and angular fragments, and the gold in the present soil within reach of the plowshare. Many of the richest gold washings of this State have been of this description, and farms, gardens, yards and the sites of houses have been sluiced away, and thousands of dollars per acre obtained from soils that had been cultivated for generations in ignorance of their mineral riches. Large tracts of this character, hundreds of acres in extent, are found in the locality already so often cited, the foot-slopes in the Pilot. The annexed diagram, fig. 23, of a placer lying on a swell of land between those represented in figures 8 and 9, illustrates this point. The whole surface of this flat swell, which is nearly a half mile in width, is covered with the quartz fragments of the old bed gravel of an enveloping placer, which has been entirely abraded, leaving its quartz and gold in the soil, with the exception of the fantastic bifurcated strip seen in the figure, which evidently was preserved from abrasion by the furrow which the moving mass had plowed a little deeper along this line. The thickness of this strip increases from a few inches at the top to more than ten feet below the singular golden cascades represented on the two arms. Happening to be present while the last of this curious placer was worked out, I was able to catch and sketch its peculiar features. This small remnant of an extensive deposit preserves, as shown in the sections, at A—A for example, all the characteristics of such drifts—a dense bed of coarse "gravel," of angular quartz fragments, at bottom, carrying most of the gold, and a thinner and more scattered layer in the middle, with visible gold particles, and the finer gold diffused through the whole ten feet of depth, in sufficient richness to justify the excavation and washing of the entire mass.

The diagram (ideal as to its lower portion, and contracted longitudinally,) also exhibits the character and origin of the gold deposits in the creek bottoms of the region, which were extremely rich when first wrought, thirty-five to forty years ago, yielding ten dollars a day to the hand, with the rudest apparatus and most unskillful labor. The gold of these creek gravels, as shown in the figure, was derived from the placers swept down from the adjacent slopes.

And it may be of sufficient interest to justify the repetition here of a fact to which I have recently called attention elsewhere, that these gravels are regularly worked over at intervals of eight to ten or twelve years, and at some of the localities, on Silver Creek, for instance, they

have been re-worked profitably half a dozen times, only the coarse gold being obtained each time by the rude appliances and methods used. The point of interest is, that the fine and diffused and scale gold which escapes in these rough washings and sluicings, evidently undergoes a process of aggregation: a fact which was noted by Professor Lieber, State Geologist of South Carolina, in his Geological Report of that State,* published before the war, but which seems to have escaped due attention. This is readily accounted for by the considerations, first, that gold is soluble in alkaline waters; and second, that these drifts are largely the debris of half-decomposed feldspathic gneisses and schists, of which the feldspathic particles are undergoing kaolinization, liberating the alkaline salts, while the silica attacks such fragments of organic matter as happen to be present, subjecting whole trunks of trees, of more than a foot in diameter, to complete silicification even while lying within a few feet of the surface, and facing the drusy rifts of the wood with perfectly terminated quartz crystals.

Raleigh, N. C., March 15, 1881.

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*First Annual Report, 2d edition (1858), p. 73.

Section V.—MANGANESE, CHROMIC IRON, COBALT AND NICKEL, ARSENIC, ANTIMONY AND BISMUTH, TIN.

Manganese.

The ores of manganese are not abundant in North Carolina so far as known, but pyrolusite, psilomelane, wad, etc., are found in small quantities in many places. They are generally associated with iron, gold and silver ores.

There is a very promising bed or vein of psilomelane in Caldwell county, 5 miles west of Lenoir. It is found in irregular and rounded masses, embedded in light colored gneissic schists, some of the masses being 10, 15 and 20 inches thick, and occupying a breadth of 3 or 4 feet of strata.

Another locality in this county is the Perkins Mine, 10 miles west of Lenoir, where a bed of oxide of manganese was opened to a depth of 6 feet, and shown to have a thickness of 1 foot.

A large bed carrying oxide of manganese is reported by Mr. S. A. Lowe, to exist 10 miles north of Dobson, in Surry county.

One-half a mile west of Blue Ridge Gap in Mitchell county is a bed or seam of earthy pyrolusite or psilomelane 2 to 4 inches thick; it occurs in feldspathic and hornblende schist, extending in a nearly east and west direction across the fields for about ⅓ mile.

There is also a small seam in the town of Danbury, Stokes county.

Laminated masses of ½ to 2 inches in thickness occur in the Buckhorn iron ore beds. (See page 129.)

There are specimens in the Museum from Nash and other counties.

A specimen of manganese ore from Jackson county gives on analysis the following:

MANGANESE ORE, JACKSON COUNTY.

	(a)	
Silica	12.25	per cent.
Alumina and sesquioxide of iron	14.10	"
Protosesquioxide of manganese	74.45	"

It is probably braunite, variety marceline.

A similar specimen was furnished by Chatham county.

Manganese is found associated with the iron ores in various parts of the State, as was stated above; at Buckhorn it is found as a silicate, and probably in the form of knebelite, as mentioned in the chapter on iron (p. 129)

Beds of manganese garnets are of common occurrence, and often of great thickness.

There is a series of beds containing manganese associated with the King's Mountain schists (slates) of Gaston, Lincoln and Catawba counties, which is superficially changed to black oxide.

One notable locality is near the old forge on Crowder's Creek, formerly operated by Mr. Briggs; it is under the west flank of Crowder's Mountain, and quite near the Yellow Ridge Ore Bank.

MANGANESE ORE, GASTON COUNTY.

	(b)	
Silica	40.395	per cent.
Oxide of iron	12.146	"
Alumina	9.029	"
Phosphoric acid (anhydride)	.030	"
Sulphuric acid (anhydride)	.024	"
Sulphide of iron	.218	"
Protosesquioxide of manganese	29.780	"
Lime and magnesia	not determined.	
Metallic iron	8.602	per cent.
Metallic manganese	21.450	"
Phosphorus	.013	"
Sulphur	.112	"

A vein of oxide of manganese crosses the road from Iron to Major W. A. Graham's residence, in Lincoln county. The bed is apparently a highly altered silicate, and is fully 6 feet wide.

A vein of manganese ore, which is believed to be the northeast extension of the above, is found about ¼ mile west of Vesuvius furnace, on the road to the Big Ore Bank.

The analysis is as follows:

MANGANESE ORE, LINCOLN COUNTY.

	(c)	
Silica	47.93	per cent.
Protoxide of manganese	12.86	"
Binoxide of manganese	5.60	"
Alumina and sesquioxide of iron	30.44	"

This has been used in a neighboring furnace as a mixing ore and with very good results.

Chromic Iron.

Small quantities of chrome are found associated with some of the iron ores of the State, the lead which crosses Guilford county for example. But it is also found as chromic iron, in coarsely crystalline masses, often of considerable size and in the form of very irregular veins or pockets in the chrysolite beds of Jackson, Yancey, Mitchell and Watauga counties. The most considerable deposits are two—one near Webster, and the other 5 miles from Burnsville, on Jack's Creek, at Hampton's. An analysis of the former by Genth gave,

CHROMIC IRON, NEAR WEBSTER.	(d)
Chromic oxide	63.32
Ferrous oxide	25.04
Magnesia	0.85
Lime	1.32
Silica and alumina	9.47

There have been no openings at either of these points, but the outcrops are such as to justify experiments at both, whenever the facilities for transportation shall be sufficiently improved. (See also p. 30.)

Cobalt and Nickel.

Small quantities of these two metals have been observed in the manganese gossans of several mines in Gaston county, (Genth's notes to Kerr's Report, 1875, p. 292).

From a considerable number of examinations of the auriferous sulphides of the State, it may be said that nickel has been found to be present in most cases, but rarely more than in traces, never, so far as known, in workable proportions. Cobalt has occasionally been observed associated with the nickel in these sulphides, but in still smaller proportions. Among these localities is the McGinn Mine, in Mecklenburg county, which has occasionally furnished cabinet specimens of cobalt minerals.

Nickel occurs in small quantities in the chrysolite rocks of the mountain region of the State. An analysis of a specimen of this rock by Genth gave 0.35 per cent. of nickel oxide (Kerr's Geology of North Carolina, 1875, p. 129); an analysis by Hanna, of a specimen which was reported to come from the vicinity of Waynesville, Haywood county, contained: oxide of nickel, 0.15 per cent., and oxide of cobalt, a very minute trace.

How far these two examples represent the entire range of chrysolite cannot now be stated.

The following notes concerning the nickel ore recently discovered in Jackson county have been kindly presented for this Report by Prof. W. B. Phillips:

"During the last two years, prospecting for nickel has been carried on in several of the western counties of North Carolina, particularly in Haywood and Jackson. The results have not been altogether satisfactory, the samples of ore showing a low percentage. The best specimens of nickel ore have been obtained from Ellijay Creek, Jackson county.

"A hand specimen received from Mr. Morgan J. Evans, Bowman's Bluff, Henderson county, said to be from the above locality, yielded as follows:

NICKEL ORE, JACKSON COUNTY.

	(e)	
Insoluble silica	69.00	per cent.
Oxide of iron } Oxide of aluminum }	5.44	"
Oxide of nickel*	18.94	"
Undetermined matter	6.62	"

*Equiv. to metallic nickel, 14.89 per cent.

"The ore appears to be garnierite. If so, it is the first occurrence of this mineral which has been noted in this State, or, indeed, in the Eastern United States. A complete analysis of the pure mineral, separated from the gangue, is now under way.

"The specimen weighed 8 ozs., and was composed of small veins of garnierite in a much decomposed syenite, and was said to be a surface specimen, or within a few feet of the surface.

"The true garnierite is a silicate of nickel, iron, calcium, aluminum and magnesium, and is found in large quantities in New Caledonia, the French penal colony. The content of nickel varies from 1 per cent. to 40 per cent.

"Even should garnierite be found in sufficient quantities in North Carolina to constitute a true ore, it is doubtful if it could be worked at a profit, as the supply of nickel from the New Caledonia mines is beyond the demands of ordinary consumption."

ARSENIC, ANTIMONY AND BISMUTH.*

"Only a few ores of arsenic and antimony have been noticed in North Carolina. Amongst these is very rare native antimony, of which a small piece was submitted to my examination by Dr. Hunter, of Cottage Home, Lincoln county. It has been found in a small vein in Burke county. An examination proved it to be quite pure.

Both arsenic and antimony are found in combination with other metals; arsenic at a few localities in Union and Gaston counties, in small quantities, as arsenopyrite or mispickel, associated with gold ores; and both arsenic and antimony in the highly argentiferous tetrahedrite of the McMakin, and the tetrahedrite of the Ludowick mines in Cabarrus county.

Bismuth has been observed as bismuthinite in minute particles associated with the gold and copper ores of the Barnhardt vein at Gold Hill, and by Dr. Asbury as bismuthite with gold ores at the Asbury mine in Gaston county; also as bismite, or teroxide of bismuth, in the same mine, and in combination with copper, lead and sulphur at Col. White's mine in Cabarrus county, probably as aikinite. The most interesting ores are the telluride of bismuth (tetradymite) and the tellurate of bismuth (montanite)—both found associated with gold ores in numerous localities—in Davidson, Cabarrus, Gaston, McDowell and Burke counties. The bismuthic gold mentioned by Shepard as coming from Rutherford, is probably an artificial product resulting from the simultaneous amalgamation of gold and tetradymite."

TIN.

Up to a few years since, no tin ore had been found in North Carolina. In 1883 it was discovered that a valuable ore of tin (Cassiterite) occurred in the region of King's Mountain. Soon thereafter explorations of the region were instituted under the direction of Dr. Chas. W. Dabney, Jr., the results of which he reports as follows†:

"I found pieces of Cassiterite from the size of an egg to the finest sand, loose and sticking in quartz, scattered over the surface in a belt beginning about the centre of the village, and extending southward a mile or more.

* Reproduced from Genth's notes in the Geology of North Carolina, 1875, p. 291.

† Journal of the Elisha Mitchell Scientific Soc., 1883–'84, pp. 79—81.

"When the clay of the hills or the gravel of the neighboring creeks was panned, a heavy black sand was obtained which yielded more or less tin.

"A number of shafts have been sunk and trenches dug along the course of the hill-tops whence the tinstone appears to have come. The rocks are mica schist and slate, with frequent veins and streaks of quartz and quartzyte. The rocks are nearly vertical, direction of outcrop northeast and southwest with all of the rocks of this country. The tinstone is disseminated through the quartz and quartzyte vein matter occurring in a belt of the rock 100 to 150 yards wide. The chief tin-bearing territory is limited on the northwest by a large outcrop of micaceous quartzyte, on the southeast side by a very large outcrop of tourmaline-bearing or massive tourmaline-stained quartzyte.

"A number of these tin-bearing quartz veins have been exposed in this territory. The surface is covered with fragments of them which the decaying mica schist and slate have left. These veins are from 2—4 feet in width. They run mostly with the other rocks, though there are frequent cross and string-veins. At places these quartz or quartzyte veins are left by the mica schists and stand up through the clay nearly to the surface, while at other places they are broken down to the level of the mica schist. At still other places where the schists and slates contained more silica, the whole formation is found now near the surface.

"According to Dr. Emmons, the village of King's Mountain is near the dividing-line between the Laurentian granite and the Huronian slates. To the east of the village the rocks are micaceous and slaty quartzytes, talcose slates and bluish crystalline limestone. A few miles west are the hornblende slates, gneiss, etc.

"Nearly all of the adjacent rocks, the mica schists and slates, the tourmaline-bearing quartz, and the massive black quartz—all show amounts of tin varying from distinct traces to 1—2 per cent.

"The Cassiterite is mostly massive or semi-crystalline; occasionally crystals are found. Hardness, 6.5 to 7; Specific gravity, 6.6 to 6.9; color, generally dark brown, but varying from this to light yellow and cream-colored, or almost colorless. Composition, mostly an impure Cassiterite, with 50 to 60 per cent. of tin, some dark brown silicious specimens running as low as 46 per cent. of tin. The somewhat rarer light colored specimens are richer in tin coming nearer the per cent. of metal (78.66) in pure dioxide of tin (SnO_2).

"The tinstone is remarkably free from those worst ingredients of tin ore, sulphur and arsenic. The lower-grade specimens do not show appreciably more than the above.

"The accompanying minerals are tourmaline, very abundant; titanic iron in more immediate relation with the Cassiterite; lithia mica, generally immediately around the larger lumps of the tinstone in the quartz; and more rarely zirkon and rutile."

Analyses by Hanna for Dr. Dabney gave, for two varieties:

CASSITERITE, KING'S MOUNTAIN.

	LIGHT GRAYISH (f).	DARK BROWN (g).
Stannic oxide	94.70 (=74.41 per ct. tin)	82.99 (=65.21 per ct. tin)
Tungstic oxide	0.92	1.14
Sulphur	trace.	0.46
Arsenic	——	trace.
Iron and manganese oxides	not determined.	not determined.
Silicic acid	1.76	2.36

Subsequent explorations of the region have been made by other parties, but as yet no workable deposits of cassiterite appear to have been discovered.

GEOLOGICAL MAP.

The primary object of the edition of the geological map which accompanies this Report (Chapter II of Vol. II) is to show the geographical and geological distribution of the ore deposits of the State. The geological features have in the main been reproduced from the map which accompanied the Report of 1875,* with some revision and alteration by me, from the records of the Survey and from my own field notes.

The ore deposits have been located largely by Mr. Hanna, from his own notes and from the records of the Survey.

In connection with the geological features of the map, a few points deserve special mention: (1) The map used as a base for the geological map of 1875 was, with reference to many localities, quite inaccurate; and in the transfer of the geology to a more accurate base map (Kerr's Map of the State, 1882), though in this I have been aided by the manuscript and published records of the Survey, only approximate accuracy can be expected.

In the subdivisions of the Archæan, it is thought best, in consideration of the primary object now in view, to follow in the main the map of 1875. The subdivision of the Laurentian into Upper and Lower has been discontinued, except that the syenitic belt, which extends across the central region of the State under the towns of Greensboro, Salisbury and Charlotte, is continued provisionally as Lower Laurentian, because of the importance attached to this region on account of its ore deposits. It would have been better, however, even in this case, to have dropped the expression, "Lower Laurentian", and to have substituted for it a designation of less geological significance.

As to the areas of the crystalline schists in the region of the Blue Ridge and the extreme western portion of the State, which on the map of 1875 were provisionally classed as Huronian, much might be said in favor of considering these as Cambrian; but their exact position is still a matter of doubt, and on the present map it is thought best to retain these areas as Huronian.

In the Mesozoic areas but little alteration has been made except in connection with the eastern region of the Jurasso-Triassic formation, the boundaries of which have been altered in places, and the area of its northern half considerably enlarged. In the revision of the central

*Geology of North Carolina, 1875, by W. C. KERR.

and northern portions of this area especially, I have made use of my own field notes. There is need, however, of a considerable amount of additional field work before the boundaries of this formation can be mapped with even approximate accuracy.

The present state of knowledge concerning the occurrence and distribution of the Tertiary and Quaternary formations in North Carolina is not such as to render possible the mapping of the several areas occupied by these or their subdivisions. In view of this fact, it has been thought best to class the entire area occupied by these—the eastern region of the State—as Cenozoic, without attempting to specify except in a very general way the regions occupied by its subdivisions. The location of the monograms of the Eocene (E), Neocene (N),—embracing the Miocene and Pliocene—and the Quaternary (Q) are intended to indicate in a general way regions which it is believed will be found to come within the limits of these formations.

The monograms and colors have been selected from those in use by the U. S. Geological Survey.

In connection with the ore deposits, it should be borne in mind that the great majority of these have been located with only approximate accuracy, very few having been located by actual surveys. Persons discovering inaccuracies in the location of ore deposits will confer a favor by promptly notifying me, so that corrections may be made in a second edition of the map.

J. A. HOLMES.

University of North Carolina.

ERRATA.

Page 127, line 2, for "New Hanover" read "Pender."
" 138, line 18, opposite metallic iron, instead of "57.26" read "57.41."
" 145, figure near top of page should be inverted.
" 167, 2nd line of foot-note, for "there" read "these."
" 178, 13th line, and p. 179, for "plate X" read "plate XI."
" 180, 23rd line, for "suface" read "surface."
" 184, 6th line, for "on" read "one."
" 191, foot-note, opposite Lead, for "2.64" read "2.46."
" 192, line 17, instead of "14 to" read "silver."
" 195, line 2, insert "less" after "was" and "had."
" 196, line 4 from bottom, for "1 3-4" and "2 3-10" read "3 3-4" and "2."
" 198, assay No. 33, for "5-100 oz." read "20-100 oz."
" 200, line 4, for "form" read "from."
" 202, line 2 from the bottom, for "exposed" read "explored."
" 210, assays 57 and 58, for ".30?" and ".13?" read "30." and "13."
" 214, line 5, for "beeh" read "been."
" 214, line 12, instead of "a" insert "an apparent."
" 216, line 6, for "Luck" Mine read "Tuck" Mine.
" 223, near the bottom, for "Nantegalee" read "Nanteyalee."
" 229, in the "Summary, cost of smelting," for ".16 1-4" read ".26 1-4."
" 230, assay No. 80, for "none" just below ".044" read "0.088."
" 230, line 18, for "0.93" read "0.39."
" 235, line 9 from bottom, for "Splaun" read "Splawn."
" 243, foot-note, assays 94 and 95, for "48-100" read "35-100," and for "50-100" read "48-100."
" 250, line 8, for "85-100" read "48-100."
" 255, line 17, for "in largely" read "is largely."
" 258, line 23, beginning with "has a small," strike out the latter part of this sentence.
" 263, line 6 from bottom, for "Fag Hill" read "Fox Hill."
" 263, line 5 from bottom, insert "Black Mine."
" 274, line 16 from bottom, for "one mile west of the Delk" read "near the Silver Valley."
" 274, bottom line, for "13.68" read "31.68."
" 275, line 4, for "Upper Laurentian" read "Lower Laurentian."
" 278, lines 9 and 13 from the bottom, and p. 279, line 7 from the top, for "Willis" read "Millis."
" 281, line 22, for "sulphates" read "sulphides."
" 285, line 4 from bottom, for "Theis" read "Thies."
" 286, line 13, for "Icenhour" read "Isenhour."
" 289, line 2 from bottom, instead of "XXIV" read "XXV."
" 292, assays 224 and 226, for "1-4" read "3-4," and for "7 1-10" read "7 7-10."
" 292, line 9 from bottom, for "in" read "is."

Page 292, line 14 from bottom, for "they" read "the ore."
" 293, line 11, for "Icenhour" read "Isenhour."
" 296, line 21, for "Manney" read "Mauney."
" 298, assay 247, for "1-10" read "6-10."
" 301, line 4 from bottom, for "Trediwick" read "Tredinick."
" 306, for "XXIV" read "XXVII."
" 309, line 18, before "probably" insert "its extension."
" 311, line 11 from the bottom, before "largely" insert "came."

INDEX TO CHAPTER II.